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DEEP SEA FISH OF THE HUDSON GORGE

Taken at Station 113 of the Arcturus and Station 114 of the Eleventh Expedition of The Department of Tropical Research

By William Beebe, Sc.D.

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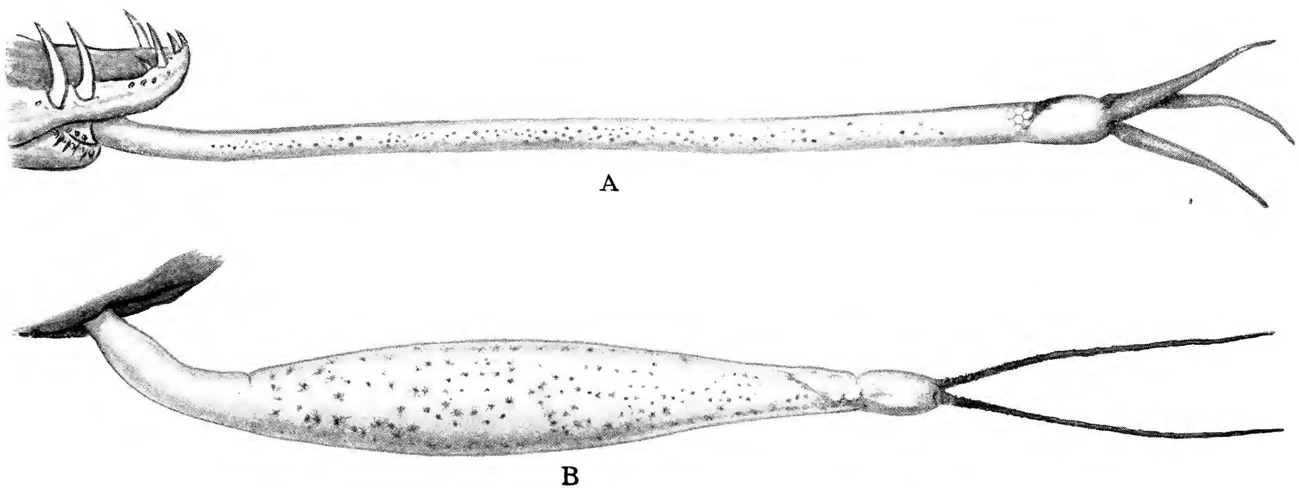

Fig. 1. A—Mental barbel *Stomias boa*. B—Mental barbel STOMIAS FUSUS, sp. nov.

Zoologica, Vol. XII, No. 1

DEEP SEA FISH OF THE HUDSON GORGE*

Taken at Station 113 of the Arcturus and Station 114 of the Eleventh Expedition of the Department of Tropical Research of the New York Zoological Society

By William Beebe, Sc.D.

INTRODUCTION

(Fig. 1)

It has always been my desire to see how close to New York City the life of the deep sea is to be found—to see within what narrow limits on the earth one could find such intensive civilization and such an absolutely unexplored field. I interested Mr. L. F. V. Drake and through his influence as President of the Salvage Process Corporation I obtained the use on two separate occasions of the powerful sea-going tug *Wheeler*. I put on board the smaller of my two Arcturus winches with its three miles of quarter inch steel wire.

Two trips were made, on July 8 and August 5, 1928. We left Brooklyn at 6:30 Saturday night and at 8 o'clock the next morning reached the vertical of a mile depth in the Hudson Gorge. This was, as close as we could make it, one hundred and twenty-five miles southeast of the Battery, in 39° 15′ No. Lat. and 72° West Long. This I have called Station 114, or the Hudson Gorge Station, being identical in position with Station 113, the last of the Arcturus Stations, where three years before I spent July 25th to 29th, making sixty hauls with various nets and trawls. Fifty-five species of deep sea fish were taken in all, of which five prove to be new.

In my summary of the results I have combined the organisms taken in Stations 113 and 114. In *Zoologica, Vol. VIII, No. 1,* pp. 22-23, I have given the data of Station 113.

The following table supplies that for Station 114:

**Contribution, New York Zoological Society, Department of Tropical Research, No. 309.*

ELEVENTH EXPEDITION

DEPARTMENT OF TROPICAL RESEARCH

Station 114, Hudson Gorge, 125 miles S. E. of New York City,
39° 15′ N. Lat. 72° W. Long.
S. S. Wheeler

Haul	Metre Net	Date	Time	Duration of Haul	Depth Fathoms
T1	½	July 8	8.26 A. M.	15 Min.	100
T2	½	8	9.50	2 Hours	200
T3	½	8	9.50	2	300
T4	1	8	9.50	2	400
T5	½	8	9.50	2	500
T6	1	8	9.50	2	600
T7	1	8	9.50	2	700
T8	½	8	1.50 P. M.	2	0
T9	½	8	2.10	2	650
T10	1	8	2.10	2	700
T11	1	8	2.10	2	750
T12	1	8	2.10	2	800
T13	1	Aug. 5	9.30 A. M.	2	500
T14	1	5	9.30	2	600
T15	1	5	9.30	2	700
T16	2	5	9.30	2	800
T17	1	5	1.40 P. M.	3	600
T18	1	5	1.40	3	700
T19	1	5	1.40	3	800
T20	1	5	9.15	15	0

LIST OF DEEP SEA FISH FROM STATIONS 113 AND 114

Superorder *TELEOSTEI*

Order *ISOSPONDYLI*

Bathytroctes drakei sp. nov.

One specimen: No. 7690, Hudson Gorge Station 114, T12. 39° 15′ N., 72° 00′ W. July 7, 1928. Taken in meter net, 800 fathoms.

Although measuring only 29 mm. in standard length, this fish shows well developed generic and specific characters. To the former belong the toothed maxilla, seven branchiostegals, the dorsal fin longer than the anal, and originating distinctly in advance of the latter fin.

It is a young fish but the shortness of the mouth is wholly unlike the young of *B. rostratus,* or the adult of any other member of the genus. In *B. rostratus* of equal length (29 mm.), the maxilla measures 5 mm., while in the present individual it is only *2.7 mm.* in length. The gape in other species, young or adult, reaches at least to the middle of the eye, while here the posterior end of the maxillary barely makes the *anterior rim* of the eye-ball. The anal rays number *fifteen* instead of from seventeen to twenty-two. The premaxillaries are *not* noticeably protruding, and although their teeth are directed forward, they are of *equal size* with those in the maxillaries. There is *no* supra-clavicular process apparent, in this respect approaching *Alepocephalus.* The color is typical of young *Bathytroctes,* black head and belly, and light gray body.

I have named this species in honor of L. F. V. Drake, Esq., through whose generosity the boat was loaned for this oceanographic work off New York City.

Length: 29 mm.
Depth of body: 2.9 (10)
Depth of peduncle: 1.7
Head: 10.2 (2.8)
Eye, horizontal: 3.3 (3)
Eye, vertical: 1.6
Snout: 3.2 (3.2)
Maxillary length: 2.7
Branchiostegals: 7

Pectoral rays: 16
Pectoral rays length: 1.3
Pectoral total length: 2.1
Pelvic rays length: 1.6
Dorsal rays: 18
Anal rays: 15
Dorsal base length: 5.1
Anal base length: 4.3
Dorsal in front of anal: 2.1
Pelvics in front of anal: 1.9

This appears to be the first specimen of *Bathytroctes* taken in the western Atlantic Ocean. The nearest record is *Bathytroctes antillarum* Goode and Bean, from 420 fathoms, one hundred miles south-east of the Mississippi delta.

Stomias boa (Risso)

Six specimens:

No.	*L'gth.*	*Sta.*	*Haul*	*Depth*	*P-V*	*V-A*	*A-C*	*Stem*	*L'gth. / Depth*	*L'gth. / Head*	*Head / Eye*
7644	27.5	114	T14	600	47	11	17	.8	11	7.2	5.5
7610	35	114	T7	700	52	10		4.7	10	6.2	6.2
6558a	106	113	T3	400	46	11	17				
6573	111	113	T5	500	48	13	18		11	9	
6558b	116	113	T3	400	49	10	17	12	13.6	5.5	4
7669	125	114	T17	600							

These specimens all fall within the range of variation as given by Brauer for this species. The individual of greatest interest is Number 7644, a young, almost larval phase of 27.5 mm. standard length. When brought up from six hundred fathoms it was white with a dense scattering of pigment along the sides. This completely disappeared in the cleared specimen. Most significant is the absolute lack of ossification throughout head and body. Not a trace of scarlet stain is visible in the cleared tissues, although Number 7610, which is less than eight millimeters longer, and was preserved in the same vial and fluid is well on the stage to adult ossification. In the smallest specimen the head is relatively larger than in the adult, and the stem of the illicium much shorter, being only as long (.8 mm) as the bulb itself. In a fully adult fish the latter has increased not at all, while the stem is twenty-six times longer.

The dentition of the small *Stomias* differs only in slight details from that of the adult: Premaxillary with a medium sized fang each side of the symphysis, a second very large tooth at the anterolateral angle of the premaxillary, curving out and down; five additional ones along the sides of which the first and third are the larger. Mandibular dentition shows an anterior tooth each side of the symphysis, then two very large fangs, set widely apart, leaning almost horizontally outward and then up, followed by six more slender teeth. The pair of vomerine teeth is as large as the anterior premaxillary pair.

Stomias Number 7610 possesses eighty vertebrae; atlas to vertical of pectoral fin 7, pectoral to ventral 47, ventral to anal fin 8, anal fin to and including urostyle 18 vertebrae.

A comparison of dimensions of my smallest individual with the largest ever taken is significant in showing a surprisingly regular development of the characters:

Length	308	mm.	27.5 = 9	per cent. of the adult
Depth	23	"	2.5 = 10	" " " " "
Head	28	"	3.8 = 13.6	" " " " "
Eye	6.5	"	.7 = 10.7	" " " " "
Total Illicium	26	"	1.8 = 7	" " " " "
Pectoral length	25	"	2.7 = 10.8	" " " " "
Ventral length	29	"	2.7 = 9.6	" " " " "

Stomias boa has a wide distribution, having been taken in the Atlantic from the Hebrides to the Cape of Good Hope, and from Greenland to New England. Also in the Mediterranean and the South Pacific.

Stomias fusus sp. nov.

(Fig. 1)

One specimen: No. 7667, Hudson Gorge Station 114, T17. 39° 15′ N, 72° 00′ W. August 6th, 1928. Taken in meter net, 600 fathoms.

This *Stomias* resembles *boa* in photophore count and in general appearance, but is set quite apart by the character of the mental barbel. Instead of having a slender, mobile stem and a large oval bulb with three tentacles, *fusus* has a stiff, spindle-shaped stem, and two tentacles.

Dimensions:

Length: 250 mm.
Depth: 20 (12.5)
Head: 21 (11)
Eye: 5.4 (1.3)
Snout: 3.2
Dentition
One-half upper jaw: 5
One-half lower jaw: 7
Weight: 28 grams
Pectoral length: 20
Ventral length: 23
Ventral rays: 5
Dorsal rays: 20
Anal rays: 22
I-P: 11
P-V: 47
V-A: 12
A-C: 15
Lateral scales: 73

The barbel arises from the center of the chin, an elongated spindle, 16 mm. in length, pale golden yellow densely flecked with black chromatophores. The terminal bulb, 1.5 mm. in length is unpigmented, bright true purple, and is separated from the spindle by a narrow black band. The bulb terminates in two elongated filaments, rather thick at the base and tapering to a fine point. They are 5.7 mm. long, wrinkled for their proximal half and jet black. In preservative the barbel has faded to white with a pale pink bulb.

The suborbital light organ is small and oval, and is purple on the lower half and white above. The lateral photophores are violet in life, the ventral ones golden yellow.

Stomias valdiviae Brauer

One specimen: No. 7613, Station 114, T10, 700 fathoms.

A single young specimen of only 26 mm. length shows all the typical photophore counts of this species. It is white, with the lines of luminescent spots black.

Length: 26 mm.
Depth: 2.5 (10.4)
Head: 2.5 (10.4)
Eye: .4 (6.2)
Pectoral: 6 rays
Dorsal: 17 rays
Anal: 20 rays
P-V: 43
V-A: 6
A-C: 16

Stomias valdiviae has been recorded from the Atlantic and Indian Oceans, but the nearest locality to the Hudson Gorge is the Gulf of Guinea off the west coast of Africa.

Stomias colubrinus Garman

One specimen: No. 6647, Station 113, T4, 450 fathoms.

A single specimen of this well-marked species came up from 450 fathoms. It is typical in every respect.

Length: 118 mm.
Depth: 11.5 (10.2)
Head: 13 (9)
Eye: 4.5 (3.9)
Pectoral length: 12.5
Ventral length: 15
Dorsal: 20
Anal: 23
P-V: 38
V-A: 10
A-C: 18

Stomias colubrinus has been taken off the Pacific coast of Panama, and near the Cape Verde Islands.

Astronesthes martensi Klunzinger

One specimen: No. 6648, Length 90 mm., Station 113, T34, 500 fathoms.

In spite of a number of rather marked variations I choose to consider this fish as *martensi* instead of erecting a new name for it. In the major characteristic with which Parr separates two groups of *Astronesthes,* relating to the relative distance from the snout of the origins of the dorsal and the ventrals, this specimen, and others from more distant Arcturus stations, are midway between the two groups,—the percentage being 1/16 in place of 1/25–1/20 and (in *A. martensi*) 1/10–1/8. It has also a smaller eye, (5.9 in the head instead of 4 to 5). These and other differences may be accounted for by age, for Brauer's specimen was only 31 mm. long, and the three of Parr's measured 48 to 50 mm., while the present Hudson Gorge individual is nearly twice this, being 90 mm. standard length. The barbel is in perfect condition, but wholly lacks the "etwa 8 kleine Faden" of Brauer's fish.

Length: 90 mm.		Pectoral rays:	8
Depth: 15 (6)		Ventral rays:	7
Head: 22.5 (4)		Dorsal rays:	15
Eye: 3.8 (5.9)		Anal rays:	16
Snout: 5.4 (4)	Lateral	O-V:	15
Barbel: 23 (1)		V-A:	19
Snout to dorsal: 46	Ventral	I-P:	9
Snout to ventrals: 40.5		P-V:	14
Pectoral length: 16		V-A:	19
Ventral length: 17.3		A-C:	12

The suborbital organ is large and egg-shaped, and so cloaked with black pigment that it points only straight forward. The barbel is entirely white, the bulb elongated and slenderly club-shaped. No filaments are present or trace of their former attachment.

Astronesthes martensi has been taken in the Indian Ocean, Red Sea, south of Ceylon, near the Cape Verde islands, and among the Bahamas.

Stylophthalmus paradoxus Brauer

Two specimens: No. 7697, Station 114, T6, 600 fathoms, No. 7645, Station 114, T14, 600 fathoms.

The larger specimen, No. 7697, 41 mm. in length, is decidedly immature, the eye-stalks being only one-quarter as long as they are in the adult, but the other characters are quite typical. Among these are the spoon-shaped jaws, the position of the fins and the peculiar intestine.

Description:

Length: 41 mm.
Depth: 1.1 (37)
Head: 4.6 (8.9)
Eye: 1.3 (3.5)
Eye-stalks: 2.5
Snout: 1.8 (2.6)
Jaw: 2.3
Pectoral length: .8
Snout to pectorals: 4.6
Exposed intestine: 1.4
Intestinal exit to caudal: 5
Caudal length: 2.85
Dorsal to intestinal exit: 2.2

Two long rows of small, black photophores extend along close to the ventral surface: above these on the mid-lateral line an alternating row of pigment blotches. The dorsal and lateral surfaces are faintly pigmented.

The immaturity of this individual is distinctly revealed in clearing. The cranium is hardly discernable, but the parasphenoid, jaws, hyomandibular, quadrate, opercles, branchiostegals, and especially the cleithra and supra-cleithra are strongly ossified. The teeth are small, sharp, evenly spaced, twelve in each upper half jaw and eighteen in the lower half. The vertical fin rays are only slightly ossified, but the urostyle, numerous hypurals, and the caudal rays are strongly marked.

The second specimen is only 4.8 mm. in length, but resembles *Stylophthalmus* more than any related genus. The fin rays are barely discernable. It is white with a patch of pigment beneath the heart, a broad band along the sides formed by the dark line of closely spaced light organs; a dense patch dorsal and ventral, near the caudal fin but not touching it. The intestine protrudes .4 mm. The snout is somewhat spoon-shaped, the eye very elliptical, dorso-ventrally, and very short-stalked. Length 4.8 mm. Depth .6; Head 1.2; Eye .4 mm.

This strange little fish has been recorded from the Atlantic, Indian and Antarctic Oceans.

Chauliodus sloanei Bloch and Scheider

Six specimens:

No.	*L'gth*	*Sta.*	*Haul*	*Depth*	*L'gth Depth*	*L'gth Head*	*Head Eye*	*P-V*	*V-A*
7695	26	114	T13	500	9	5.6	4.8	19	26
7687	28	114	T11	700	13.3	7.5	5.3	19	26
6630	65	113	T45	1200	13	7.2	4.5	19	25
7668	230	114	T17	600	9.2	7.4	4.3	19	25
7636	235	114	T13	500	8.6	7.8	5	19	26

No. 7695 is a white, transparent individual, apparently larval, as intensive staining and clearing reveal no trace of ossification. Compared with a full-grown specimen 235 mm. in length, the relative proportions of head and eye, and number of photophores show no differences. The depth in relation to the length is considerably less in the larva, about 13 to 8, while the elongated first dorsal ray is about one-half the relative length that it is in the adult. In this very young individual this ray is directed backward, not forward, and is extremely soft and

pliable, flat and ribbon-like. The second and third dorsal rays are a third longer than the succeeding ones, the extra length being as pliant as the "bait" in *Lophius*. There are no signs of scales, the myomeres numbering sixty.

The relative length of the paired fins is unlike that in the adult. In this larva they are almost equal, whereas in adults the ventrals are about twice as long as the pectorals. In the young the anterior long canine of the lower jaw is one-fourth the entire length of the mandible, while the adult has a fang quite half as long as the jaw. It is remarkable that although the teeth and jaws are long and strong enough to be functional, yet they are as pliable as rubber, and show not a trace of calcification.

Fish No. 7695 is two millimetres shorter than the transparent larva, but is translucent, semi-opaque. When stained and cleared it shows many points of interest.

The unusual relative depth of the body to the length, nine as compared with thirteen in the 28 mm. fish, is explicable when a full-grown *Cyclothone signata signata* becomes visible in the stomach of the young *Chauliodus*. It can be identified with certainty; as to genus from the clearly distinguishable and ossified head bones and dentition, as to species from the lack of dermal pigment, and as to subspecies because of the presence of seven, not six, supra-lateral photophores. The head and fins of the *Cyclothone* are strongly ossified; the head is 4.3 mm. in length, and the total length 15 mm. Of this, the posterior portion is curved around, lying closely pressed to the back. In this curled position the ingested fish occupies a little over half of the full length of *Chauliodus*.

In spite of being less in length than the unossified larva, this young fish is far more advanced in development. The head is well ossified, especially the jaws, teeth, hyomandibular and humeral arches. This is also true of all the fin rays. There is no trace of vertebral calcification except very fine outlines of the first five. The vertebrae of the entire column can, however, be distinguished, and the scale outlines can be made out in favorable light.

There are five teeth in each half jaw, the first and second premaxillary, and the first and third mandibular being much larger than the rest. Each one is accompanied by a small understudy or auxiliary tooth, ossified near the tip, but with the basal three-fourths clear and pliable, so that it can bend back out of the way when food is being seized, thus keeping in perfect shape until needed to replace the loss of its companion. On the premaxillary, between the second, third and fourth teeth are two, small, outwardly pointing, solitary teeth. The inferior half of the maxillary enters the border of the mouth with ten small, oblique denticles. The frontal crest is conspicuous, and honey-combed with three lateral foramina and a longitudinal open tube. Eighteen branchiostegals, short, vertical, and evenly spaced are distinct.

The opercles and preopercles are clearly ossified, and both of them linear, the same being true of the several cleithra. Thirteen pectoral rays are supported on five faint but distinct brachials. There are seven ventral rays and the pelvic girdle is well developed, the pubic bones extending far forward to a length of

3.2 mm., fully half the distance to the pectoral fin. In the dorsal are six rays, the anterior, elongated one soft, still directed posteriorly, and measuring 7.8 mm. This is very close to the relative length of the same organ in the adult, showing the importance of the filament throughout the life of the individual. The anal fin shows twelve rays.

The urostyle is strongly ossified, and is attended by rather faintly indicated hypurals and eight large and strong epurals. There are nineteen rays which properly enter into the functional caudal fin, with eight small superior, and three inferior supplemental basal raylets.

In the two fully adult specimens taken in the Hudson Gorge, one a male, measures 235 mm. in length, while the other, a female, is 230 mm. long. The chief difference of note is in the size of the eyes, those of the female being considerably larger. The weight of the longer specimen is 55 grams, while the shorter female with her full-sized ovaries weighs 62.5 grams. The relative depth to length apparently increases with age, as the table shows, the two largest fish being respectively 9.2 and 8.6, as compared with 13.3 and 13 in smaller individuals.

There are many other ontogenetic points of interest, but I leave these for a more comprehensive monographic treatment than can be permitted in this brief paper.

Chauliodus sloanei has been taken from both east and west sides of the Atlantic, in the Pacific from Japan to New Guinea and in the Indian Ocean.

Chauliodus dentatus Garman

One specimen: No. 6559. Length 68 mm. Station 113, T45, 400 fathoms.

It is with reluctance that I admit the validity of this species, considering the variation of numbers of photophores in *C. sloanei.* But I have not been able quite to bridge the gap between the two forms, while other supposedly diagnostic characters are of most slight foundation.

Description:

Length: 68 mm.	I-P: 10
Depth: 8.6 (8)	P-V: 21
Head: 10 (6.8)	V-A: 29
Eye: 2 (4.5)	A-C: 11

The abnormal depth into length of 8 in such a moderate sized *Chauliodus* is accounted for by the great distension of the stomach, the outlines of an ingested fish being clearly visible through the opaque skin.

Chauliodus dentatus is known only from the type which came from the Society Islands.

Genus *CYCLOTHONE*

Of this genus I took 1355 individuals in seventeen hauls at Station 114. Careful analysis shows no correlation between the light and dark forms and any

definite zone of distribution. Of the total catch 861 were dark, and 494 (or 36 per cent) were light.

Cyclothone signata signata; 251 specimens from Station 114.

Cyclothone signata alba; 64 specimens from Station 114.

Cyclothone microdon; 1025 specimens from Station 114.

Cyclothone acclinidens; 15 specimens from Station 114.

The hundred fathom distribution was as follows:

500	fathoms	68%	light	32%	dark
600	"	19%	"	81%	"
700	"	47%	"	53%	"
800	"	23%	"	77%	"

No *microdon* was taken within 400 fathoms of the surface, and only a single *signata* above 100 fathoms. At all Arcturus stations where abundant catches of *Cyclothone* were made the proportion has always been about twice as many dark as light forms.

In a 26.5 mm. *Cyclothone signata* the ovaries were fully developed, each 4.5 mm. in length and containing a total of 530 eggs, averaging .4 mm. in diameter. A female *Cyclothone signata alba* of 29 mm. had 4 mm. ovaries containing 764 ova. In a count of several individuals I found that both *signata* and *microdon* averaged thirteen trunk and nineteen caudal vertebrae.

C. signata has been taken in the Atlantic, Pacific and Indian Oceans, *alba* in the Atlantic and Indian, *acclinidens* in the Atlantic, Pacific, Indian, and the Antarctic, while *microdon* is recorded from all five oceans.

Idiacanthus fasciola Peters

One specimen: No. 6649, Station 113, T35, 600 fathoms.

This is the only member of this family secured on the two trips to the Hudson Gorge. It measured 122 mm. in length. The species has been taken in the Atlantic, Pacific and Indian Oceans.

Vinciguerria ucetia (Garman)

Two specimens: No. 7611, Station 114, T9, 650 fathoms.

In several places where I have dredged in distant parts of the oceans this little fish has proved to be abundant, but in the Hudson Gorge I took only two. The length of these was 11.8 and 18.2 mm. and it was surprising to find that in the smaller, the skeleton, even the vertebral column, was very strongly ossified. There were 22 trunk, and 17 to 18 caudal vertebrae. *Vinciguerria* has been collected in the Atlantic, Pacific and Indian Oceans.

Argyropelecus olfersi Cuvier

One specimen: No. 6625b, Station 113, T43, 1000 fathoms.

Although only 10.7 mm. long, and taken in the same net as *A. hemigymnus*, there is no question of identificaion, the preopercle and abdominal ridge with their characteristic spines being well grown and ossified. The young of this species has, in addition to the strong, downwardly directed spine of the preopercle, a small, outward pointing one which later becomes reduced. In the present individual the anterior thirteen vertebrae are completely ossified, but in the remainder the calcification is confined to the upper and lower portions. This species has been taken in many parts of the Atlantic, as well as in the Pacific and Indian Oceans.

Argyropelecus hemigymnus Cocco

Two specimens: No. 6591, Station 113, T32, 164 fathoms; No. 6625a, Station 113, T43, 1000 fathoms.

Both individuals are very young, measuring only 10.7 and 13.2 mm. standard length. The species has been found in the Atlantic, Pacific and Indian Oceans.

Sternoptyx diaphana Hermann

Nine specimens: 6603a, Station 113, T37, 800 fathoms; 7614, Station 114, T10, 700 fathoms; 7635, Station 114, T13, 500 fathoms; 7643, Station 114, T14, 600 fathoms; 7648, Station 114, T15, 700 fathoms (2); 7665, Station 114, T17, 600 fathoms (2); 7679, Station 114, T18, 700 fathoms.

All the specimens were post-larval, or at least not more than half grown. The species has been recorded from the Atlantic, Pacific and Indian Oceans.

Derichthys sp. nov.

One specimen: No. 7670, Station 114, T17, 600 fathoms. Length 185 mm.

This specimen appears to belong to this genus, but has greatly elongated, anteriorly directed, tubular nostrils. I reserve final identification until I have had it stained and cleared.

Nemichthys scolopaceus Richardson

One specimen: No. 6569, length 190 mm. Station 113, T4, 450 fathoms.

This individual agrees fairly well with the common Atlantic species of Snipe-billed Eel. It has 301 vertebrae and 14 branchiostegals.

It is wide spread through the Atlantic Ocean, and has also been recorded from the Pacific north of New Guinea.

Serrivomer beani Gill and Ryder

Two specimens: No. 6568, Length 385 mm. Station 113, T4, 450 fathoms; No. 6611, Length 285 mm. Station 113, T39, 1000 fathoms.

This pair of Saw-toothed Eels differs from the superficial description of Gill and Ryder in a number of particulars, but the inadequate original description together with the present paucity of material makes it inadvisable to recognize these differences as specific.

The major characters of No. 6568 are as follows:

Standard length 385 mm.

Depth: 7 (55)	Snout: 24 (2.5)
Head: 60 (6.4)	Dorsal rays: 130
Eye: 3.5 (17)	Anal rays: 116

This species has been taken in various parts of the Atlantic, and near Hawaii. If it is considered as identical with *S. sector* the distribution may be extended to the west coast of Sumatra.

Family MYCTOPHIDAE

At the Hudson River Gorge Station three hundred and forty-one individual myctophids were taken, of which seventy-two were larvae, or too young to admit of certain identification. The adults were distributed among twenty species, as follows:

Myctophum valdiviae Brauer; *4 specimens;* recorded from Atlantic, Pacific and Indian Oceans.

Myctophum glaciale Reinhardt; *124 specimens;* recorded from northern Atlantic and Arctic waters.

Myctophum laternatum Garman; *1 specimen;* recorded from Atlantic, Pacific, and Indian Oceans.

Myctophum fibulatum Gilbert and Cramer; *1 specimen;* recorded from Atlantic and Pacific Oceans.

Myctophum coccoi Cocco; *11 specimens;* recorded from the Mediterranean, Atlantic, Pacific and Indian waters.

Myctophum affine Lutken; *4 specimens;* recorded from Atlantic, Pacific and Indian Oceans.

Myctophum punctatum Rafinesque; *1 specimen;* recorded from the Mediterranean and Atlantic.

Myctophum benoiti Cocco; *7 specimens;* recorded from Mediterranean, Atlantic, and East Indian waters.

Myctophum reinhardti Lutken; *4 specimens;* recorded from Atlantic, Pacific and Indian Oceans.

Myctophum hygomi Lutken; *3 specimens;* recorded from Mediterranean, Atlantic, and Indian waters.

Lampanyctus maderense Lowe; *12 specimens;* recorded from Atlantic and Mediterranean waters.

Lampanyctus warmingi Lutken; *3 specimens;* recorded from Atlantic and Indian Oceans.

Lampanyctus gaussi Brauer; *73 specimens;* recorded from Atlantic Ocean.

Lampanyctus tenuiforme Brauer; *2 specimens;* recorded from the Indian Ocean. When more detailed descriptions are available this may prove to be *Lampanyctus nobilis* Taaning from the north Atlantic.

Lampanyctus micropterus Brauer; *1 specimen;* recorded from Atlantic and Indian Oceans.

Lampanyctus gemmifer Goode and Bean; *1 specimen;* recorded from Atlantic Ocean.

Lampanyctus pusillus Johnson; *11 specimens;* recorded from Atlantic Ocean.

Diaphus dumerili Bleeker; *2 specimens;* recorded from Atlantic and East Indian waters.

Diaphus gemellari Cocco; *3 specimens;* recorded from Mediterranean, Atlantic, and Indian waters.

Lampadena sp.; *1 specimen*, too injured for specific identification.

The larval myctophids averaged fifteen millimetres in length, and showed three pairs of pigment spots on the epidermis, one before each eye, one each at the anterior base of the pectoral and ventral fins. A few photophores were faintly adumbrated, especially four of the postero-anal light organs.

In relative specific abundance there was a decided disparity, since three-fourths of the total number of adult myctophids belonged to two species, *Myctophum glaciale* and *Lampanyctus gaussi.*

Malacosteus niger Ayers

One specimen: No. 6651, length 80 mm., Station 113, T5, 500 fathoms; recorded from the Atlantic, Pacific and Indian Oceans.

Bregmaceros atlanticus Goode and Bean

One specimen: No. 7642, length 21.5 mm., Station 114, T14, 600 fathoms.

Dorsal elements I-47, anal 57. Color: Creamy white with a thick scattering

of stellate chromatophores over the dorsal part of the head and body, less abundant below. Opercula immaculate. Iris greenish silver.

This species has been taken in various parts of the Atlantic.

Urophycis chesteri Goode and Bean

2250 specimens collected and counted; about 1000 thrown back without counting.

Taken in every net of a twenty-four hour series of half-hour surface hauls. Station 113, T6 to T29, July 25 and 26, 1925.

These hake were, without exception, larval, post-larval or young up to five inches in length.

Hake are found all along the Atlantic coast of the United States in depths of from one hundred to five hundred fathoms, and are probably the most abundant fish on the edge of the continental shelf.

Citharichthys arctifrons Goode

Nine specimens: Numbers 6636 and 6637, Station 113, D1, 1000 fathoms.

Measurement of an average specimen.

Length 42 mm.	Mandible: 3 (3.7)
Depth: 13 (3.2)	Dorsal: 81
Head: 11.3 (3.7)	Anal: 65
Eye: 3.5 (3.2)	Vertebrae: 36

A common species in the deeper waters of the Gulf Stream.

Glyptocephalus cynoglossus (Linnaeus)

Twenty-one specimens: No. 6560, one, Station 113, T3, 400 fathoms; No. 6638, nineteen, Station 113, PT3, 69 fathoms; No. 6854, one, Station 113, PT3, 69 fathoms.

All the specimens are young, averaging 40 mm. They are intermediate between *h* and *i* in Fig. 71, p. 175, "Eier und Larven von Fischendes Nordischen Planktons." The eye has just begun its migration. Ours lack the pigment spots on the interneurals and interhaemals.

The eyes and color are on the right side, and there are 58 vertebrae, 108 dorsal and 90 anal rays.

This fluke is found on both coasts of the northern parts of the Atlantic Ocean.

Genus *MELAMPHAES*

Three species of this deep sea genus were taken at the Hudson Gorge Station.

Melamphaes mizolepis Gunther

Three specimens: No. 7682, length 88 mm., Station 114, T19, 800 fathoms; No. 7678, length 43 mm., Station 114, T18, 700 fathoms; No. 7666, length 10 mm., Station 114, T17, 600 fathoms.

Recorded from the Atlantic, Pacific and Indian Oceans.

Melamphaes nigrescens Brauer

Two specimens: No. 6610, length 41 mm., Station 113, T39, 1000 fathoms; No. 6616, length 3 mm., Station 113, PT1, 1000 fathoms.

Recorded from the Atlantic and Indian Oceans.

Melamphaes suborbitalis (Gill)

One specimen: No. 6615, length 63 mm., Station 113, PT1, 1000 fathoms.

Recorded from the Atlantic and Indian Oceans.

Helicolenus maderensis Goode and Bean

One specimen: No. 6575, length 152 mm., Station 113, V1, 546 fathoms.

In life this fish weighed 128 grams. It was brilliant scarlet with some dark mottling along the back and considerable silver on the under parts. The iris was greenish gold.

Recorded from moderately deep water off the entire coast of the eastern United States, and near the Madeira Islands.

Lycenchelys verrillii (Goode and Bean)

One specimen: No. 6576, length 128 mm., Station 113, D2, 69 fathoms.

This species has been taken off the north-eastern coast of the United States.

Melanocetus niger Regan

One specimen: No. 6552, Station 113, T35, 600 fathoms.

Length: 15 mm.	Longest tooth: 1.9
Head: 9.1	Dorsal: 14 rays
Mandible: 11.8	Anal: 4
Interfrontal: 4	Pectoral: 21

Although a young fish, all the major characters are well developed. It is certainly not *M. johnsoni,* and shows no radical differences from *M. niger* although this species is known only from the Pacific.

Caulophryne jordani Goode and Bean

One Specimen: No. 6530, Station 113, T35, 600 fathoms.
A single specimen of small size is typical in every respect.

LIPACTIS MEGALOPS sp. nov.

One Specimen: No. 6633a, Station 113, T43, 1000 fathoms.

Near *L. tumidus* of Regan but with much larger eyes (5.9 in head instead of 8.3), and an external, sessile cephalic bulb. The basal part of the illicium is subdermal but well developed, while the external, flat-topped bulb rests in a groove on the outside of the dermal envelope. The snout is 5.9 in the head instead of 4 as in *tumidus.*

Length: 10 mm.
Depth: 7.5 (1.3)
Depth of actual body: 5.9
Head (to gills): 5.9 (1.7)
Eye: 1 (5.9)
Snout: 1 (5.9)
Maxillary: 1.6 (3.7)

Type Location: The type is deposited in the collection of the Department of Tropical Research in the New York Zoological Society.

Name: *megalops,* from the unusually large size of the eyes.

HAPLOPHRYNE HUDSONIUS sp. nov.

One specimen: No. 7696, Station 114, T6, 600 fathoms.

For detailed description see the succeeding number of ZOOLOGICA, Volume XII, Number 2.

New York Zoological Society

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HAPLOPHRYNE HUDSONIUS

A NEW SPECIES; DESCRIPTION and OSTEOLOGY

By William Beebe, Sc.D.

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HAPLOPHRYNE HUDSONIUS

*A New Species; Description and Osteology**

By William Beebe, Sc.D.

Preamble—Genus *HAPLOPHRYNE*

(Figures 2, 3, 4, 5)

It would not be unreasonable to establish a new genus for the Hudson Gorge fish which I am about to consider, but we know so little about individual and specific variation in the Ceratioidea that I chose a more conservative policy. Brauer in 1902 established the genus *Aceratias* for three species of fish. One of these was *A. mollis*. Regan, ten years later, removed *mollis* to a separate genus which he called *Haplophryne*. His original definition of this genus was "with depressible teeth and without nasal papilla." In 1926 he redefined *Haplophryne* as follows: "Sphenotic spines not prominent. Mouth rather small; teeth moderate. Illicium subcutaneous, small, with short stem and terminal bulb; a pore on upper surface of snout, at the margin of which the skin is attached to distal end of illicium. No barbel. Preopercular spine simple, concealed beneath the skin. Skin thin, loose, translucent, unpigmented."

Viewed through the translucent skin, the fish I have under consideration fits this generic definition, except that the reference to the cephalic pore should be expanded to include double, sessile bulbs outside the skin.

Before taking up in detail this new specimen from the Hudson Gorge, I will review the four individuals called *mollis* by Regan. This will show our present knowledge and indicate the extent of variation. Only when more material is available can these variations be catalogued with certainty as individual or specific.

The quartet of described specimens of *H. mollis* is as follows:

A—14 mm. long. Valdivia Expedition. Indian Ocean.
26° 3′ 6″ So. Lat.; 93° 43′ 7″ East Long. Depth 1203 fathoms.

B—32 mm. long. Dana Expedition.
25° 7′ N. Lat.; 19° 20′ West Long. South of the Canaries.

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*Contribution, New York Zoological Society, Department of Tropical Research, No. 310.

COMPARISON OF FOUR SPECIMENS OF H. MOLLIS[1]

	(A) Valdivia	(B) Dana	(C) Terra Nova	(D) Stanford	Extremes of Variation
Dorsal and Anal rays	3	3	3	3	
Caudal rays	8	8	9	9	8–9
Pectoral rays	14–16	15	15	18	14–18
Depth to length	2.1	1.6	1.5	2.7	1.5–2.7
Head to length	2.5	1.9	1.7	2.4	1.7–2.5
Snout to head	3.6	3.3	4	?	3.3–4
Eye to head	5.5	9.2	5	7	5–9.2
Eye to snout	1.5	2.8	1.2	?	1.2-2.8
Mandible to head	2.6	1.7	3.5	1.5	1.5–3.5
Illicium	absent[2]	subdermal; opening into pore	rudimentary; subdermal	?	various
Anus position (lateral)	asymmetrical	symmetrical	symmetrical	?	sym. or asym.
Anus position (longitudinal)	mid-body	¾ back	⅗ back	?	½–¾ back
Cephalic spines	?	small sphenotics	?	2 strong supraorbitals	0-2
Rostral denticles	3, isolated	? premaxillary	?	?	0-3
Teeth, upper jaw	9	11	5	?	5–11
Teeth, lower jaw	13	11	6	14	6–14
Gape	to front of eye	to mid-eye	to front of eye	behind eye	In front to far back of eye
Eyes	telescopic	normal	normal	normal	normal–telescopic
Mouth	moderate horizontal	small oblique	small horizontal	large vertical	small–large vertical–horizontal
Branchiostegals	4	?	?	5	4–5

[1] This data is compiled both from printed descriptions and from drawings.
[2] Probably overlooked, owing to dermal opacity.

C—7 mm. long.[1] Terra Nova Expedition. New Zealand. Surface.

D—100 mm. long.[2] Stanford Expedition. Galapagos Islands. From stomach of Green Turtle.

The fifth column of the accompanying table shows the extraordinary range of variations, some of which must ultimately prove to be specific or generic. In a few instances the variation may be the result of distortional relaxation of the tissues, or confusion resulting from surface examination. I have avoided the latter difficulty in my own specimen by thoroughly clearing it and staining the skeleton with a vital bone stain.

HAPLOPHRYNE HUDSONIUS sp. nov.

Type number 7696: Hudson Gorge Station 114, T6. 39° 15′ N. Lat., 72°, 00′ W. Long. July 7, 1928. Taken in a metre net at a depth of 600 fathoms.

Field Characters: A small, white, balloon-skinned, elongate, ceratioid fish, with three large, curved rostral denticles; dorsal and anal three-rayed; double, minute, sessile, cephalic bulbs; anus sinistral, three-fourths toward tail.

Measurements of Type:

Standard length: 15 mm.	Maxillary: 2.8 (in length 5.3)
Head: 7.5 (in length 2)	Dorsal: 3 Anal: 3
Total depth: 6.6 (in length 2.2)	Pectoral: 17
Body depth: 5.1	Caudal: 9 (2 upper, 3 lower simple)
Total breadth: 5.7 (in length 2.6)	Caudal length: 8.1
Body breadth: 4.3	Snout to dorsal: 11.3
Eye: 1.3 (in head 5.8)	Snout to anus: 10:7
(in interorbital 2)	Ocular angle: 24° down[3]
Interorbital 2.7	Ocular divergence: 18° forward
Snout: 1.6 (in head 4.7)	Mouth angle: 12° up

The first thing we notice in the cleared specimen is the absolute hyalinity of the very thick, balloon-like casing of skin. The thickest portion of the fish is at mid-head, and from here the crown curves regularly and steeply downward to the mouth. Posteriorly the line of the back is almost a straight slope to the tail. The chin curves rapidly back to the end of the mandible, whence the contour is straight.

[1] I assume the given length of 10 mm. is total length.

[2] The given length of 27 mm. is, judged by all the other measurements, an original misprint for 100 mm.

[3] The angles were taken as soon as possible after death.

The superior contour of the actual body within the dermal envelope follows closely that of the outside, except that the profile of the skull from the supraoccipital to the premaxillary is flat rather than curved. So complete is this envelope that the tip of the jaw is the only spot where the skeleton contacts with the outside. The other points of penetration are the paired cephalic bulbs and the gill-openings, the anus and fin rays.

Although at first glance the dermal balloon appears perfectly homogeneous, yet in the course of manipulation an outer layer of epidermis peels almost completely away. This is of considerable thickness, and under low power shows innumerable, minute, needle-like spicules, giving, in some lights, a frosted or flocculent appearance. Under higher magnifications a great number of very small, rounded or oval figures are seen, but offer no clue as to whether they are vestiges of former scales.

In spite of the small size of this fish the skeleton is remarkably well ossified, the various skull and branchial elements, the vertebrae and fin rays showing an even, scarlet stain. In sharp contrast with this, the optic envelopes, the coelomic contents, and the pectoral and trunk muscles are differentiated as pale, translucent, orange tissues.

Whether the imperfectly ossified edges and ends of some of the bones represent solely a juvenile condition, or whether this is a permanently arrested phase due to unknown bathypelagic factors we do not as yet know. As Lütken says in writing of the skull of an adult Ceratias, "Le crâne a la même structure spongieuse ou fibro-lamelleuse que la colonne vertébrale, les os de l'épaule etc.; mais il y entre de plus un élément cartilagineux assez considérable, certaines parties du chondrocrâne primordial restant dans l'état primitif, soit sur les confins des os qui se sont formés a ses dépens, soit sous les ossifications parastotiques développées au-dessus d'elles ou dans leur portion périphérique."

The fact of the perfection of development, in spite of the diminutive size, of the illicium, and its elaborate musculature, also the quite undegenerate aspect of the almost wholly sub-cutaneous dorsals and anals, seem to suggest that the swollen dermal envelope is a larval or juvenile character. It may be useful as a buffer protection of sorts during the late stages of development, aiming toward such an adult form as *Dolopichthys*.

I have included in my brief review a few characters, such as the ray segmentation which may seem trivial, but until we know more about the comparative physiology of these deep sea fishes we cannot be sure of what is trivial or what is preeminently significant.

Cranium

The top of the cranium is not very unlike that of *Borophryne* as shown by Regan, but with the ethmoids much less in extent, with the interfrontal hiatus of a different shape, and the anterior half of the skull wider. The median hollow or groove shown so conspicuously in all the Ceratioid skulls of Regan is only slightly developed. Anteriorly it is distinguishable but disappears at the supra-occipital where the skull flattens out. Behind this the median line again shows a slight hollowing or furrowing between the two laterally prominent epiotics.

Looking down on the cranium, its junction with the vertebral column can clearly be made out between the two great masses of trunk muscles which sweep forward on each side of the neural arches to their attachment along the entire posterior aspect of the epiotics. The cone-like, concave facet of the basioccipital extends backward and obliquely upward to engage the corresponding portion of the first vertebral centrum. On each side of the foramen magnum two thin, wing-like projections from the exoccipital articulate with two from the first vertebra. The neural arch of this latter bone is broader than its posterior fellows, quite spineless, and instead of slanting backward it is directed forward, closely applied to the faintly ossified posterior cranial region. If this fish has nearly completed its calcification this is an interesting arrested phase, if not, the neural arch would in time have become wholly fused with the periphery of the foramen magnum.

The entire posterior upper surface of the cranium is formed by the large epiotics, which join medially and quite shut out the supra-occipital from the posterior outline. The supraoccipital is large and roughly circular, occupying the center of the cranium. On each side are large parietals, concave where they abut on the supraoccipital, widely rounded laterally over the sphenotics, and sending a small flattened spine back along the outer contour of the epiotics.

Returning again to the posterior edge of the cranium, the post-temporals show a broad condylar face for articulation with the supra-

cleithrum. They are roughly square in shape, extending forward along the sides of the cranium, and engaging the epiotics and the pterotics. The pterotics continue the lateral aspect forward, lying alongside the epiotics and parietals, and showing a pronounced articulation for the hyomandibular. The sphenotic forms the posterior half of the supraorbital rim, and just posterior to the eyeball gives rise to a strong, outjutting lateral spine .7 mm. in length, sharp, slender and straight, which extends out beyond the circumference of the eye to the very surface of the cutaneous envelope.

The frontals are well separated, leaving a cartilaginous hiatus which is linear rather than (as is indicated in *Borophryne*) circular. Each constitutes a fourth of the supero-anterior border of the orbit; anteriorly the frontal curves down beneath the nasal tissue, ending in two sharp, lateral points connected by a deep, ossified bay. A ridge of bone runs from the center to each point, that to the outermost being much the stronger. Posteriorly the frontals touch the supraoccipital narrowly, and the parietals along a wide extent.

The prefrontals are distinguishable as two slender, hour-glass like bones, closely resembling the interhyals in shape. They extend from the region of the anterior end of the parasphenoid back to the inner, anterior fork of the frontal. The vomer is a transversely winged bone, broad-arrow-barb-like, extending across the anterior ends of the parasphenoid. The ethmoids are too transparent for clear definition.

Viewing the skull from the side, the strong, thin parasphenoid is seen rising well forward beneath the nasal tissue, and extending straight backward, visible through and exactly bisecting the translucent, pale brown sphere of the eyeball, and on back to the base of the skull. The prefrontals are dimly discernible through the mist of narial tissue. Back of and lateral to the suture of the premaxillaries is a small lachrymal.

Palato-Pterygoid Arcade

The hyomandibular is less strongly ossified than any of the bones with which it is associated, but it shows a broad superior surface, articulating with the pterotic and extending forward as far as the sphenotic. Directly below, a strong connection is made with the opercular condyle. The deeper cheek area is much more strongly muscled

than it is ossified, but a faint connection of the hyomandibular with an interhyal can be made out. No symplectic is visible.

The quadrato-angular articulation is by means of a delicate, wide, needle-fine, transverse condyle. From this point the tissue of the quadrate is stretched between three lines of strong radiating ridges, one upward and slightly forward to meet the palatine, a second up and somewhat backward which connects with the pterygoid, and a third obliquely back, passing beneath the preopercle.

The pterygoid shows ossification only as an irregular plate, twisted into three planes, and sending forward a long finger which meets the still more slender palatine.

Jaw Apparatus

The jaws are well ossified. The premaxillaries viewed from above are slightly separated at their suture, and show an abrupt height at this point. Laterally this height rapidly narrows to a flat, even-edged jaw rim extending well over the mandible and reaching almost to its supero-posterior angle. The maxillary can be distinguished as a thin rod of bone beginning at the point of narrowing of the premaxillaries and lying loosely along its upper edge.

Three large, curved, talon-like denticles arise out of the ethmoid cartilage, quite clear of the jaw, their roots close and showing a large area of ossified, anastomosing filaments. One denticle is median, while the other two have their tips rotated laterally. From the very front of the premaxillaries, close to their symphysis, two minute teeth project straight ahead. The rest of the rim of the upper jaws shows a few incipient teeth of very small size, irregularly placed. In front of the lower jaw are five pairs of strong teeth, the central pair straight and extending horizontally outward. The four lateral pairs are curved like the three superior teeth, but are smaller. When these are viewed from directly below the jaw, they are seen to be elevated well above and anterior to the bone, arranged along a line of cartilage. This seems to bring them into the same category of dermal denticles as the nostril trio.

Behind these ten teeth and along the anterior rim of the lower jaw are the real mandibular teeth. Four large, curved ones are seen

on each side of the middle line, forming a true second row of lower teeth.

The mandible has a very noticeable projection at the symphysis, directed downward. Posteriorly the jaw broadens rapidly and the distance from the superior to the inferior angles at the back is contained only 2.3 times in the entire mandible length. Half way back along the mandible occurs the fork of the dentary—both prongs extending almost to the posterior edge of the jaw. The articular fills in between the upper and lower arms and forms a deep, rounded bay of articulation for the condyle of the quadrate, halfway down the long, oblique, posterior aspect.

Opercular Bones

The opercle is a large, fish-tailed bone, presenting an anterior articulation with the hyomandibular. At the point of junction a strong but short spine rises upward and obliquely forward. From this point two strong ridges of bone diverge at right angles, one reaching up and back to and across the supracleithrum, and the other down and back, just bisecting the first branchiostegal. Between the ridges extends a thin lamina of bone, deeply incurved from the two points.

The preopercle is elongated, rather narrow, slightly angled—in fact very boomerang-like in outline, with a ridge of bone along the anterior edge. The upper end dies out insensibly over the hyomandibular, yet showing hardly any difference in plane; and the lower portion terminates near the angular, overlapping but quite distinct from the quadrate. The entire bone is flat and shows no trace of spines at any point.

The interopercle, viewed laterally, is a long, narrow sliver of bone, in appearance like a strong mid-rib to the expanded, leaf-like ceratohyal beneath. It lies midway between and parallel to the lower half of the preopercle and the heads of the second to fifth branchiostegals. It is slightly broader at the upper end, and is intimately connected with the junction of the interhyal and epihyal. The ossification of the interopercle ends about three-fourths of the way to the angular. For the last quarter, its course is outlined clearly in cartilage to the very point of the prominent angular condyle.

I can distinguish no trace of a subopercle.

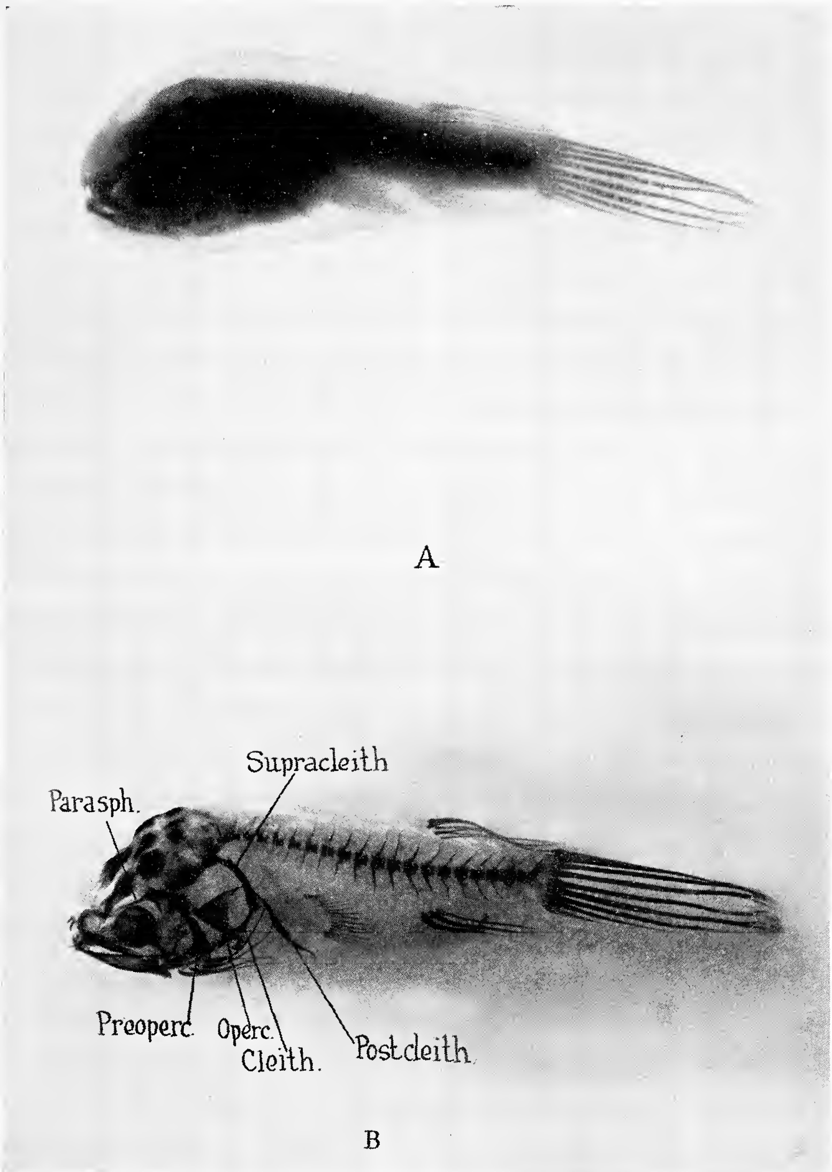

Fig. 2. HAPLOPHRYNE HUDSONIUS, sp. nov. A—Uncleared, as the fish came up in the net. B—Side view after clearing. Illustrations from unretouched photographs.

Fig. 3. HAPLOPHRYNE HUDSONIUS, sp. nov. A—Lower view of the whole fish. B—Top view of the whole fish. Illustrations from unretouched photographs.

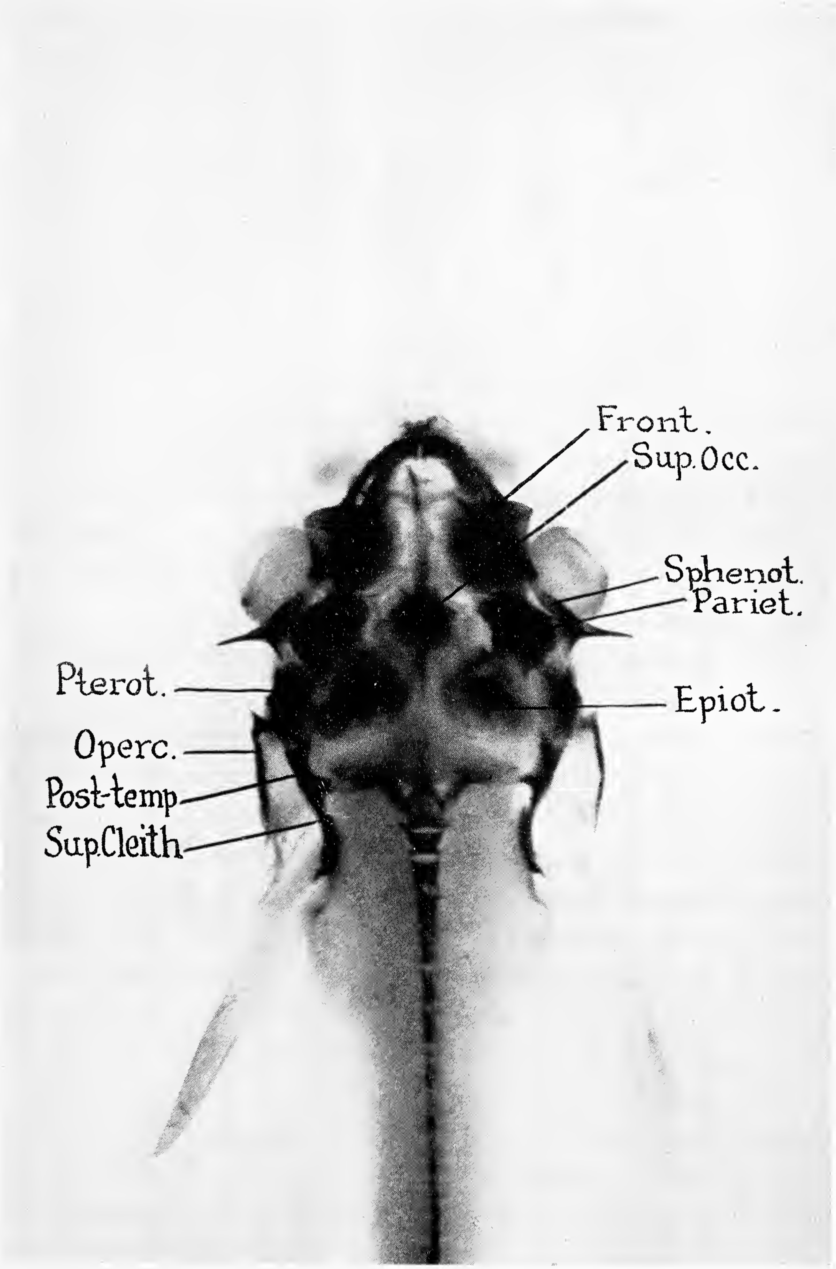

Fig 4. Haplophryne hudsonius, sp. nov. Top view of skull.

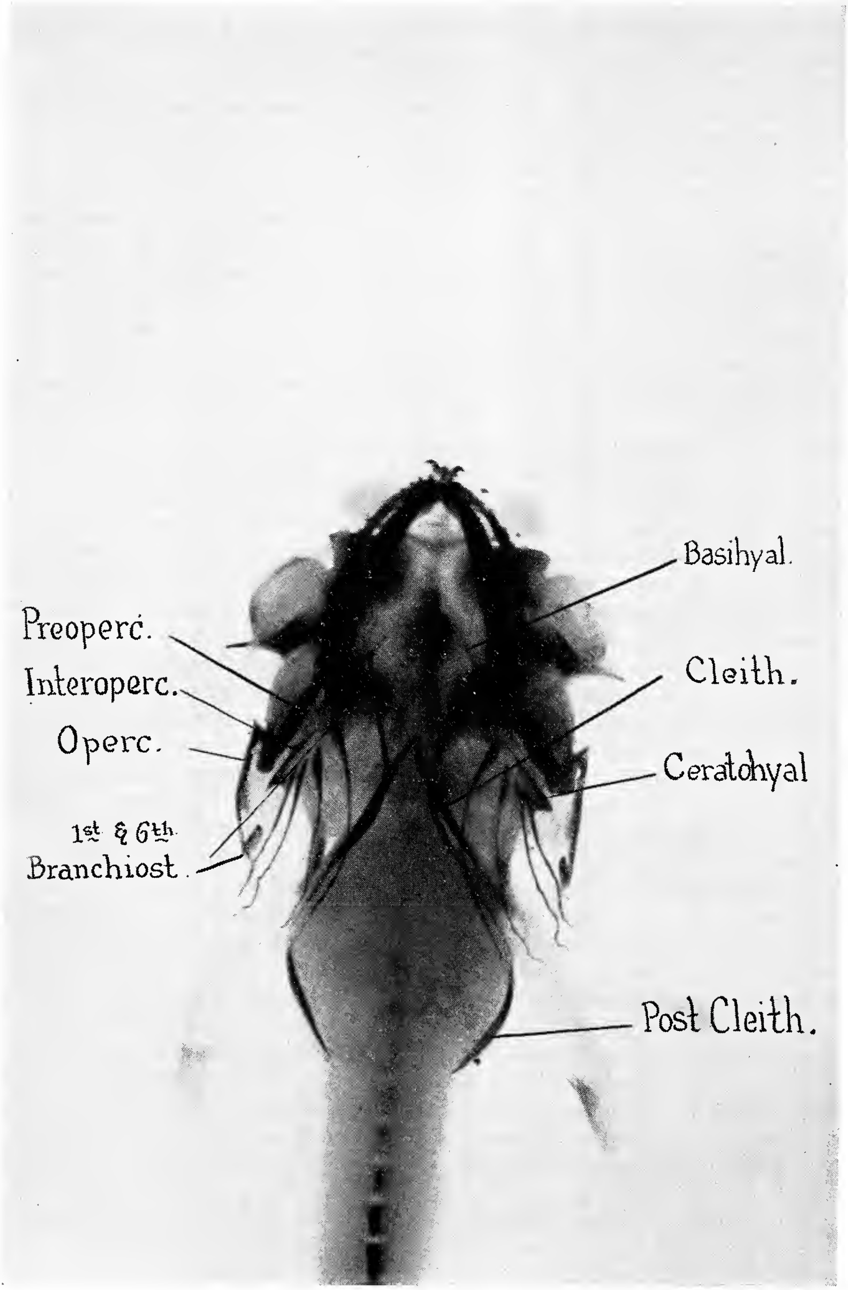

Fig. 5. HAPLOPHRYNE HUDSONIUS, sp. nov. Lower view of head. Illustration from an unretouched photograph.

Hyoid Arch

From the lower part of the hyomandibular arises the elongate, very slender, hour-glass shaped interhyal, extending obliquely down and backward, beneath the angle of the preopercle. Posteriorly it articulates at right angles with the epihyal. This is a very short bone and hardly to be differentiated from the long ceratohyal. Just beneath the quadrato-angular articulation the long basihyals arise and extend far forward, almost uniting on the mid-throat. These latter are more strongly ossified at the ends than in the center. No glosso or urohyals are distinguishable.

There are six branchiostegal rays.

The first branchiostegal is very long, and originates well forward on the basihyals. Curving inward and backward its attenuated tip reaches as far as those of the other branchiostegals. It is 4.6 mm. over all, and shows very little widening. None of the branchiostegals reaches as far back as the gill opening.

The second to fifth arise side by side from the lower leaf of the ceratohyal, their heads parallel with the rod-like interopercle.

The sixth (rearmost) arises from no visible bone or cartilage, from a point just ventral to the tip of the lower fork of the opercle, and extends up and across the junction of the cleithrum and supracleithrum. It is the shortest of all, being only 2 mm. in length. Like the succeeding ones it has a strong bony ridge along one side, and widens at the anterior end into a lacrosse-stick shape.

Branchial Arches

The gills show clearly through the bones of the side of the head, but no detail can be made out as to supporting structures. The gill openings are small, round (.16 mm. in diameter), and open at the vertical of the seventh vertebra.

Vertebral Column

The general direction of the column is a gentle rise headward of about 20° from the horizontal ventral surface of the fish, up to the first vertebra, which makes a sharp dip forward to the foramen mag-

num. Or if we consider the line of the vertebrae as horizontal, then the first vertebra and the head are deflected 40°. The chief characteristic is the great linear height of the neural and haemal arches and their unusually vertical disposition.

There are twenty vertebrae, of which twelve are trunk and eight caudal. The neurapophyses of the anterior vertebrae are wide and tall, forming a triangular arch of bone, very slightly thickened at the summit and ending in a short point. Posteriorly the arches increase considerably in height, but become very narrow, the canals consecutively lessened by the filling in of bony tissue from the apex of the arch. As we approach the tail vertebrae we find a relatively small perforation while each neural spine has lengthened into a sort of wavy, vertical osseous pennant. The most anterior neurapophysis is directed forward, but the succeeding ones are vertical up to the thirteenth or the first caudal, when they acquire a backward slant.

Haemapophyses are wholly lacking on the first two vertebrae, while on the succeeding three they are downward pointing spikes. From the sixth on the haemapophyses duplicate the neural arches, lacking only the extreme length of the spines with their wavy points. The haemal arches of the trunk are more or less vertical, but at the thirteenth vertebra they assume a decided backward slant, more pronounced than that of the neural arches.

Zygapophyses are found on the first to seventh vertebrae in the form of long, slender spines, directed forward and upward, almost touching the central part of the neural arch in front, and of no articular value whatever. On the first vertebra these are provided with wing-like expansions which articulate with processes from the exoccipitals.

There is no trace of ribs.

Caudal Fin and End of Vertebral Column

The next to the last vertebra has a normal perforated neural and haemal arch, but the spines themselves are prolonged to twice their usual length, and flattened out posteriorly into long, club-shaped expanses, which end respectively at the summit and the base of the fan-shaped tail support. Just above the reduced canals in this penultimate vertebra, two narrow, leaf-shaped projections arise from near the

base of the neural and haemal arches, and extend straight out to the full length of the preceding apophyses.

The last vertebra consists of a normally shaped anterior half-centrum, giving rise to a slightly undulatory urostyle, which lies in high relief along the upper anterior face of the caudal support, reaching half-way to its summit. At the base of the urostyle there is a round perforation from side to side, enclosed by the ascending boundary of the lower part of the basal tail bone.

Although the tail support is well ossified, I can make out no division into epi- or hypurals. This fan shaped bone appears quite homogeneous.

There are nine caudal rays and the only hint of a division of the basal bony support is in the very slightly wider interval between the four upper and the five lower rays. The split bases of all the rays overlap the basal support as much as .4 mm. while the base of the uppermost ray projects even beyond its anterior border. The bases are not stellate like those of the dorsal and anal rays, but end in an elongate, blunt, finger-like projection.

The thick body envelope extends a little beyond half the length of the rays. The uppermost and the two lower are short and extend less than half the total length of the others. These central six are ex-cutaneous and functional, and are equal in length—7.5 mm. over all. The central four are branched at the tips, and all are distally furnished with an expanded, leaf-like, colorless blade of tissue. Counting down from the uppermost long rays the sequence of segmentation is as follows:

2nd ray	8				segments
3rd ray	10	plus	branch	4	"
4th ray	12	"	"	4	"
5th ray	13	"	"	4	"
6th ray	11	"	"	2	"
7th ray	10				

The three outermost short rays have only one or two indistinct segments.

Dorsal Fin

The three rays of the dorsal fin begin far back on the body, four-fifths of the distance from the snout to the tail. The bases of the three

rays arise so close together and so obliquely that, viewed laterally, all are actually between the verticals of the neural spines of the 13th and 14th vertebrae. The base of the third ray rests on the trunk proper, while that of the first is raised obliquely upward so that it is halfway between the body of the fish and the external surface of the cutaneous envelope. There is no hint of bony supports, merely the short, oblique lateral muscle bands. In front, a longer muscle, the levator, extends almost to the tip of the 12th neural spine.

Like all the other fin rays, each of these dorsals arises from two bases, placed laterally well apart. In the first dorsal this width is .32 mm. This bilateral fission persists throughout much of the length of the ray, although a short distance from its proximal end the space becomes filled with transparent tissue. Each ray half is flat, the base is slightly expanded and presents a three-pointed face for the attachment of the muscle.

The direction of the rays is very obliquely backward, almost paralleling the contour of the trunk. They are exceedingly flexible and wavy. Close to the tips of the rays, just before they protrude from the skin each show cross segments, typical of soft fin rays in general. There is only one in the first and longest ray, two segments in the second, and three in the lowermost or third. Distally the rays protrude from the skin, each fine terminal point showing osseous structure, and enveloped in a flat, vertical leaf of clear tissue. The total length of the first ray is 4 mm., of which .7 mm. extends above the outer skin. The tips of the dorsal rays reach almost a millimetre beyond the base of the outer caudal ray.

Anal Fin

The anal fin is identical with the dorsal both in relative longitudinal position, number of elements and in general structure.

Pectoral Girdle and Fin

The shoulder girdle may be taken to begin at the junction of the posttemporal and the supracleithrum. This latter bone is long and slender and curves down and back from the postero-lateral rim of the cranium to midway between the posterior spines of the opercle.

This bone appears to be double, a separate but closely applied element being discernible internal to and hence almost hidden by it. The second is almost as long as the supracleithrum, its upper end projecting not far from the post temporal, and affording a point of attachment for an important lateral bundle of muscles which jut off obliquely from the main vertebral trunk mass. I cannot be certain of its identity if indeed subsequent ossification does not make it an inherent part of the supracleithrum.

At the lower end of the supracleithrum the cleithrum proper bends forward and twists as it bends, curving as a long, thin, slightly flattened rod beneath the ceratohyals and heads of the branchiostegals, to end on the mid-throat, where the very thin, elongated points almost touch. This spot is on a transverse level with the heads of the second pair of branchiostegals.

Behind and a short distance above the lower extremity of the supracleithrum arises the postcleithrum, separated a very short distance from the more dorsal member. It runs down and back and almost surrounds the spherical body cavity, being closely applied to the golden viscera, except for the very short distal tips. It is even more slender than the other bones of the shoulder girdle and is flattened, with a raised linear midrib. Close to the junction of the two anterior girdle bones and internal, a round flat ossification is all that can be made of the scapula.

The total absence of ribs has already been mentioned, and it seems appropriate here to indicate the part which the cleithrum, postcleithrum, and the fifth and sixth branchiostegals play as a partial substitute for ribs in functioning as a visceral suspensorium. A thin but strongly fibred sheet of muscular tissue extends tautly over the body cavity, transversely across the entire length of the postcleithrum, both before and behind, and ending at its tip. Anteriorly this muscle sweeps on until it reaches the cleithrum, and ends in a long attachment to that bone. On its way it includes a large extent of the elongated fifth and sixth branchiostegals, passing over and attached to them. The other four branchiostegals are on a higher level and quite free.

The pectoral fin is composed of seventeen well ossified rays, the sixth from the bottom being the longest, 1.7 mm. in length.

These are arranged along the curved top of the pectoral "palm" over an arc of about one-third of a circle. The five longest have four

segmentations each, while dorsally and ventrally these are reduced in succession to three, two and one, the outer three rays possessing no cross segments. The free tips of the rays show enlarged leaves of hyaline membrane. The pectoral fins are really functional, for they project well above the cutaneous envelope, the rays and body of the limb to well below the attachment of the outermost ray being free.

The greatest length of the sub-ray part of the pectoral, from the center of the ray base to the cleithrum junction is 2.4 mm. The "palm" width from the first to the seventeenth ray base is 1.6 mm. as compared with .5 mm. at the narrowest part of the "wrist." The only trace of ossification of the brachials is a fairly well outlined, small, superior radial.

The split base of the rays is reflected in the entire musculature of the pectoral member. The anterior row of struts is supported by a stout muscle sheet attached along the external face of the junction of the supracleithrum and cleithrum, extending some distance along each bone. The posterior ray bases are controlled by a smaller band of muscle finding its proximal attachment along the corresponding area of the postcleithrum. From base to ray base these two muscle areas are well separated, it being possible to look clearly down between them.

Body Cavity and Viscera

The coelomic cavity is spherical and is partly enclosed and wholly supported by the long, slender postcleithra and cleithra. Its posterior boundary is at the vertical of the ninth vertebra. The anterior half of this region is almost homogeneous, orange, and yolk-like in appearance. The folds of the intestine occupy the posterior hemisphere.

The anus is asymmetrical as noted by Brauer, but not mentioned by Regan for *mollis*. It is 1.6 mm. to the left of the mid-line, and slightly in advance of the anterior origin of the anal fin. The anus is 4.3 mm. from the caudal fin, thus being three-fourths of the body distance from the snout. This position is at the vertical between the twelfth and thirteenth vertebrae, thus marking exactly the division between trunk and caudal portions of the body. From the anus the colorless intestine winds forward and inward, reaching the midline 2.7 mm. in front of the anus, and entering the visceral area between the tips of the slender, incurved postcleithra. Little can be distinguished

of intestinal detail, except some large rounded glands which appear to line the compressed stomach.

Illicium

The tentacle bulbs are two in number, side by side, close together, colorless, pear-shaped, projecting clear of the surface (.16 mm.) of the epidermis, their bases sunk in a common depression. Their position, viewed laterally, is above the center of the nostrils. Just beneath the skin they unite in a single vertical, colorless stalk, which immediately joins the upright illicium stem. This is an ossified, very thin, slightly flattened needle bone, .37 mm. in length, slanted forward at an angle of 45° with the vertebral axis. It is attached by its delicate base to the top of the expanded anterior tip of the basal bone support. This latter is 2.1 mm. in total length, extending slightly forward of the illicium stem attachment, and backward in a depression of the cranium.

Some distance back, along the top of the horizontal basal bone, a tiny ossified sliver stands upright, possibly a vestige of what in *Lophius* is the second illicial tentacle. The origin of this basal spine is at the center of the supraoccipital and this is its only point of attachment. It has a decided upward slope and no connection anteriorly with the ethmoid or other cartilages.

The musculature of the basal bone of the illicium is surprisingly complex. To take only the more evident muscles, one pair extends from the expanded anterior end back to the mid-parietals, its fibres raised well above the level of the frontals. A second originates near the posterior end of the basal bone on the supraoccipital and runs obliquely forward to the inner anterior spine of the frontal, while a third pair begins just behind the expanded anterior head of the basal rod at about the place of origin of the second tentacular vestige, and runs obliquely forward and outward, over the body of the frontal to the external frontal spine. At least two pairs of tiny muscles control the short, vertical illicium stem, all of course being imbedded in the cuticular envelope.

Nostrils

These are very large and conspicuous but not nearly as exaggerated as the corresponding organs of *Rhynchoceratias* or of *Aceratias*

macrorhinus. Viewed from above, the nostrils are seen to be well separated (1.2 mm. interval), only slightly elevated above the cutaneous envelope, and half way between the eye and the snout. Laterally they appear pear-shaped, the large end resting close to the lachrymal vestige, and about as deep as the eye diameter. There is a large, round anterior opening, and a second, oval, higher up and obliquely backward facing the eyes. Seven folds of olfactory laminae are visible, one upon the other.

Eyes

The eyes are relatively large for the size of the head, occupying one-fourth of the total distance from the snout to the base of the pectoral (junction of the supracleithra and cleithra). The eyeball is round and quite lacking in black, reflecting tissue, being of a homogeneous, pale yellow brown after clearing. Its normal position shows a 24° ocular angle downward, and 18° of divergence forward. From directly overhead, only a fifth of their diameter is concealed by the curved edges of the sphenotic and frontals, while the orbit of the cutaneous envelope almost exactly bisects the eyeball. They are in no sense telescopic or monocular in vision.

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NOTOSTOMUS BEEBEI

A NEW SPECIES OF DEEP-SEA MACRURAN FROM BERMUDA

BY LEE BOONE

VOLUME XII. NUMBER 3
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Fig. 6. *Notostomus beebei* Boone sp. nov. Type: Nearly natural size. Photograph by Julius Kirschner.

Zoologica Vol. XII, No. 3

NOTOSTOMUS BEEBEI

A New Species of Deep-Sea Macruran from Bermuda.[1]

By Lee Boone

Preamble—Genus *NOTOSTOMUS*,[2] A. Milne Edwards.

(Fig. 6)

Strikingly conspicuous among the thousands of bathypelagic macruran crustaceans obtained by the twelfth Expedition of the Tropical Research Station of the New York Zoological Society to Bermuda, under the direction of Dr. William Beebe, is a new species, ***Notostomus beebei,*** represented by a magnificent spectrum-red animal quite six inches long. In the light of present knowledge this genus is to be regarded as one of the rarest of deep-sea Macrura, since only thirty-four specimens representing eighteen distinct species have been captured by all the deep-sea expeditions prior to the Beebe-Bermuda dredgings. Of these, nineteen individuals were taken in the north Atlantic by the *Michael Sars*. Murray and Hjort (See "Depths of the Ocean," 1912, p. 386, fig. 425) state that five species, four of which are new, are represented. It is to be regretted that diagnoses of these new species have not yet been recorded.

Notostomus beebei is the fifteenth species of the genus to be described and the nineteenth member to be recorded, unless it prove identical with one of the undescribed new species mentioned by Murray and Hjort, in which event *N. beebei* becomes the eighteenth member. The specimen before me measures 141 mm. or about 5.5 inches from tip of rostrum to tip of telson, making it among the largest known specimens of the genus. It is the seventh species to be described from the deep-sea fauna of the Eastern coasts of the Americas, *N. gibbosus* A. Milne Edwards, originally taken by the Blake off Grenada, Antilles, in 627 fms. being the genotype. *N. elegans* M. Edw. was taken in the Gulf of Mexico, 955 fms., by the Blake. *N. brevirostus* Spence Bate, said by him to be a near relation of variety of *N. gibbosus* M. Edw., was taken by the Challenger off Pernambuco, Brazil, Stanley Kemp considers this identical with Bate's *N. perlatus*

[1] This paper properly should have been delayed until the trawling data of the Bermuda Oceanographic Expedition was published, but as the description was completed at an early date it has been thought best to bring it out at once. The exact locality of the capture of the new species was 32° 16′ No. Lat.: 64° 36′ West Long., five miles south of Nonsuch Island, Bermuda, at a depth of nine hundred fathoms. Ed.

[2] Contribution, New York Zoological Society, Department of Tropical Research, No. 318.

also taken by the Challenger near the Philippine Islands. Bate himself indicated his awareness of this close relationship, noting both *perlatus* and *brevirostus* as varietal differences from *N. gibbosus*.

N. robustus Smith, 1884, was taken by the Albatross off the east coast of the United States and *N. vescus* Smith 1886, also off the east coast of the United States, by the Albatross, in 2949 fms.

N. murrayi Bate was taken in the southern Atlantic near Tristan da Cuhna, in 1900 fms. by the Challenger, while *N. atlanticus* Lenz, 1914, taken in 1640 fms., west of the Azores, completes the list of described species known from the entire Atlantic.

Two species are known from the tropical American Pacific, of which *N. westergreni* Faxon, 1895, the type was taken by the Albatross off the coast of Ecuador in 1740 fms. The second record of the species was a specimen taken off the Cape of Good Hope in 800 fms.; the first female of this species was taken by the Arcturus at station 74, in 900 fms.

The second species from the tropical American Pacific is *N. fragilis* Faxon, 1895, taken off Cocos Island in 700 fms.

The other three described species of *Notostomus* were taken by the Challenger and described by Bate. One of these, the above mentioned *perlatus,* was taken near the Philippines in 2150 fms. and by the Percy Sladen Trust Expedition south of the Chagos Archipelago in 1200 fms. while *N. patentissimus* Bate was taken in 2150 fms., south of the Philippines, and *N. japonicus* Bate was taken in only 565 fms., south of Japan, the least depth at which a *Notostomus* has been recorded.

N. gibbosus A. Milne Edwards, was also taken by the Beebe Expedition at 1000 fms.,—net 192, June 19, 1929, a single specimen, spectrum red, which curiously measures from tip of rostrum to tip of telson, 141 mm., or exactly the same as does the new species. The eye in *N. gibbosus* is substantially larger than in *N. beebei,* the cornea of the former measuring 5.1 mm. long diameter, while that of *N. beebei* measures 3.8. The rostral formula is also different and the rostral shape is likewise distinctive. In fact the rostral shape and formula of *N. beebei* is strikingly different from that of any of the known members of the genus.

The present specimen of *N. gibbosus* curiously possesses the unbroken rostral-orbital carina of *N. gibbosus* on one side of the carapace, while the opposite side has this carina interrupted behind the orbit and directed obliquely upward as in *N. robustus* S. I. Smith. It is highly probable that capture of additional specimens will prove these two species

identical. Prof. Smith's description of the species is much more satisfactory than that of Dr. Milne Edwards.

Notostomus beebei, sp. nov.

Type: Locality, five miles south of Nonsuch Island, Bermuda, Lat. 32° 16′ N., Long. 64° 36′ W., May 25, 1929. Taken in net 124 at a depth of 900 fathoms. Type in the collections of the Department of Tropical Research of the New York Zoological Society, Field No. 29213.

Technical Description: Rostrum about 20.5 mm. from tip to orbital angle; carapace 45.0 mm. from orbital angle to posterior margin, abdominal segments one to six inclusive 54 mm. long, telson 25 mm. long. Carapace robust, compressed in the median dorsal line forming a strong carina which is moderately convex forming a sort of crest, which is more elevated anteriorly, terminating about opposite the orbital angle, and which is regularly, very finely denticulated throughout its entire length. There is a concave, non-denticulated excavation interrupting the dorsal carina, beginning about opposite the orbital angle and terminating distally about opposite the distal margin of the basal antennular segment. The dorsal margin of the rostrum anterior to this excavation is compressed, carinate, armed with a compound quadrispine fused basally, at the margin of the dorsal excavation and followed anteriorly by seven subequal and subequally spaced small, sharp, upward and forward directed spines, which are spaced along the down sloping rostral carina. Beyond the most anterior of these spinelets is the long, acute forward pointing apical spine which is 5.0 mm. long. The inferior rostral margin is armed with three short, acute, obliquely downward-pointing spines, spaced subequally, the most anterior of which is opposite the first spine of the superior margin. There is a carina on each side, converging anteriorly in the apical spine of the rostrum and running back along the inferior rostral margin to a point just behind the orbital angle, and terminating slightly above, but not fusing with the orbital carina which begins about 2 mm. behind the frontal margin and extends back quite to the carinated posterior margin of the carapace, having a length of 45 mm. Below this carina and separated from it by a distinct sulcus there is on the hinder half of the carapace a shorter carina about 18 mm. long approximately paralleling the orbital carina. There is a short, wide, postorbital spine. The antennal spine is longer and flares outward obliquely. The antennal

or second lateral carina runs from this spine backward, uniting with the carina of the extreme lateral margin posteriorly, where the latter converges with the carinate posterior margin of the carapace. Anteriorly this lateral carina curves around along the frontal margin, having its origin in front of the antennal spine. There is a short slightly oblique hepatic carina uniting the orbital and antennal carina.

All six abdominal segments are carinate in the median dorsal line, this carina terminating on each third, fourth, fifth, and sixth, segments in a small, sharp spine, directed posteriorly. The telson has a deep excavated sulcus throughout its entire length. The caudal fan has the inner blade narrowly oval, tapered and shorter than the telson. The outer blade is much wider, broadly oval distally and rounded, with a subdistal spine on the outer lateral margin and is longer than the telson.

The eye has the stalk smaller basally, dilating distally but less so than the terminally placed, ovoid cornea, which is shining black.

The antennulae have the basal article excavate beneath the eye and with a spine distally on the raised outer lateral margin; the second and third articles are short, chunky, the distal margin of the second joint recurvate in a lateral view; the inner flagellum is exceedingly slender, and after the first thirty annulations is very finely articulated, having a length of 70 mm. The outer whip is very thick for the first 15 mm. of its length; it is broken off in the type at a length of 35 mm.

The antennae have a short thick basal article, with a spine at the outer distal angle, the second and third articles are stocky, their combined length about two-fifths of that of the scaphocerite, the flagellum is 10 inches long, smooth and fine. The scaphocerite exceeds the length of the rostrum by about 20 per cent. of its own length. It is oval, with its greatest width about two-fifths of its length; the inner lateral margin more convex than the outer, which is thickened and produced distally in an acute spine which projects beyond the narrowed, rounded margin of the carina. There is also a median longitudinal carina on the scale.

The legs and pleopoda afford no specific characters.

The illustration of the species was made by Mr. Julius Kirschner of the American Museum of Natural History under my direction.

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NEW DECAPOD AND ISOPOD CRUSTACEANS FROM GONAVE BAY, HAITI

By Lee Boone

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NEW DECAPOD AND ISOPOD CRUSTACEANS FROM GONAVE BAY, HAITI[1]

By Lee Boone

INTRODUCTION

(Figs. 7, 8, 9, 10)

Preliminary survey of the extensive collection of Crustacea, obtained in exploration of Gonave Bay, Haiti, conducted by the Tenth Expedition of the Department of Tropical Research of the New York Zoological Society, under the direction of Dr. William Beebe, has resulted in the classification of nearly a hundred species, chiefly Decapoda, including many rare West Indian species, in large series. Among those are a new species of spider crab, *Teleophrys beebei,* a new sponge-dwelling marine shrimp, *Corallocaris perlatus,* and a remarkably exquisite new marine Isopod, *Paracerceis edithae,* of which diagnoses with illustrations are herewith presented. Full report of the Crustacea, which involves approximately a five hundred percentum increase of the known Haitian fauna, will be issued later.

I am indebted to Dr. William Beebe for the privilege of preparing this paper and to his artist, Mrs. Edith Thane, for preparation of the illustration of the isopod, and to Mrs. Helen Ziska, for the drawings of the crab and shrimp.

[1] Contribution, New York Zoological Society, Department of Tropical Research, No. 319.

Teleophrys beebei sp. nov.

(Fig. 7)

Type: Field No. 2749, an ovigerous female, was taken from Lamentin, Gonave Bay, Haiti, and is deposited in collections of the Department of Tropical Research of the New York Zoological Society.

Material Examined: Type ♀ and female paratype from corals a fathom deep, from Lamentin Reef, Haiti.

Distribution: Restricted to the type locality.

Name: This remarkable little species is named in honor of the leader of the expedition, Dr. William Beebe.

Diagnostic Characters: Carapace longer than broad; no marginal spines, dorsal surface broken into a series of lobes. Merus of ambulatories broadly cristate, suboval, margins unbroken, dorsal surface deeply pitted.

Color: (Recently preserved formalin specimen) Vivid carmine, maculated with large white areas, two on the gastric areas anteriorly branching narrowly forward to the orbital margin, separated by a median red area, posterior to which they are united by a white band across the mesogastric region, and continuing posteriorly as wide white areas on each side of the cardio-intestinal region and

diverging out to the posterolateral margin. A similar large white area occurs midway the high lateral wall of the carapace, and is repeated on the proximal parts of the meral joints of the first and second ambulatory legs, which lie below and adjacent to this white area of the sidewall of the carapace. The lateral and distal margins of the merus, the distal part of the propodus, and the proximal and distal parts of the dactyl, of the ambulatory legs are maculated with white.

Habits: This quaint little crab makes its home in the crevices of the shallow water corals. The sculpturation and color pattern of its carapace render it more like a fragment of coral than a crab and its remarkably developed toes are especially modified for living in this type of environment.

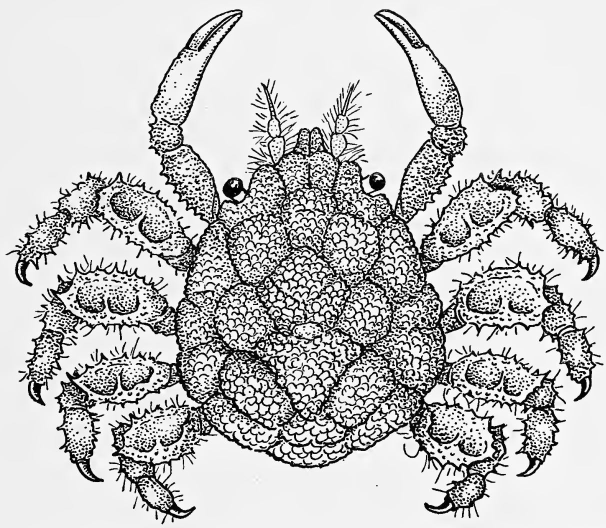

Fig. 7. *Teleophrys beebei* sp nov. Type × 5. Drawn by Helen Ziska.

Technical Description: Carapace broadly pyriform, longer than wide, 8 mm. long from tip of rostrum to posterior margin, 6.4 mm. maximum width, across the branchio-cardiac region; entire surface paved with rather coarse, elevated, rounded granules. Region of the carapace sharply defined; carapace broken into numerous swollen lobes. Rostral horns extending not quite as far forward as the second joint of the antennae, triangulate, with the lateral margins rendered denticulate by the large granules; interrostral sinus linear. The superior and outer orbital margins are entire; the superior orbital border is swollen forming a large rounded lobe which is circumscribed by a linear sulcus. A short median longitudinal sulcus extends back a short distance from the base of the rostrum, the area on either side of this sulcus being an elevated linear series of rounded, spinose granules. The mesogastric region is swollen, and is especially elevated on each side where the white areas are confluent with the median red area; the mesogastric

region is rounded; behind this the cardiac region forms a rounded subtriangular lobe with the apex directed posteriorly; and followed posteriorly by two smaller rounded lobes, side by side, which emphasize the intestinal region. The branchial region is divided into three lobes, two being along the lateral margin; the third being a longer lobe, along the posterolateral margin; separated from this lobe by a deep diagonal sulcus there is a fourth, elongate lobe on the inner branchial region and separated from the cardiac lobe by the deep sulcus which circumscribes the latter. The sidewalls of the carapace are deep on the posterior and median parts, gradually tapering anteriorly. It is covered by the same type of granules as the dorsal surface and bears an irregular depression chiefly in the large white spot. The female abdominal belt is sub-circular, seven-segmented; the lateral margins of the belt being heavily fringed with long white setae. In the ovigerous type specimen the outer distal branches are long, slender, heavily fringed with setae, and curved, one above the other, around the outer margin of the brood-pouch, increasing its depth, basket fashion.

The internal antennae are stocky and fold upon themselves longitudinally within the fossett which lies beneath the rostrum.

The external antennae have the proximal joint enlarged, granulose, and produced to a rather broad bluntish triangular tooth; the second joint arises from an excavation in the inner distal border of the first joint, and is somewhat dilated distally, extending a short distance beyond the tip of the rostral horns; the third joint is much smaller than the second, the flagellum is very slender, consisting of five or six small, linear joints which are heavily fringed with long setae.

The external maxillipeds are typical of the genus; the ischium is nearly twice as long as wide, with its proximal border diagonal; its lateral margins subparallel, the inner distal angle produced into a roundish lobe; the merus is approximately as high as its greatest width, which later exceeds the width of the ischium; the inner distal angle of the merus is excavate for the reception of the three-jointed palp.

The chelipeds (female) are slender and when folded, the carpal joint projects but a short distance beyond the rostrum. The basal joints are strong, the ischium is stocky, produced to a stout triangular point on the inner distal ventral-angle reinforcing the union with the merus; the merus is long, narrow, roughly trigonal with the dorsal surface rough with coarse granules; the carpus is short, convex and granular on the outer surface; the propodus is long and slender, about one and one-half times the length of the merus; the outer face of the propodus is granulose proximally, but smooth and gently rounded for the remainder of the length; the fingers are long, slender, comprising approximately two-fifths of the length of the propodus; the inner cutting edge of each finger is crenulated into seven or eight teeth; the distal end is rounded, spoon-shaped and finely crenulated.

The ambulatory legs present the most striking characteristic of the species; they are subequal, slightly decreasing in length from the first to the fourth pairs in the order named. The proximal joints are short and close-set; the merus of this species is the most remarkably cristate of any member of the genus. The central or main portion of the merus is raised and roughly granulose; the anterior lateral margin is produced into a wide, convex, marginal laminate process which

increases in width distally and bears on the dorsal surface along its line of union with the main part of the merus a series of two deep subcircular pits; the posterior lateral margin of the merus is even more widely produced, forming a flaring rounded plate which is especially produced at the distal border; this plate is deeply concave on its dorsal surface and bears two deep circular pits near its fusion with the central part of the merus; the carpus is large, with the dorsal surface rough and granulose and the lateral margins cristate; the propodus is no longer than the carpus but is much narrower, trigonal, with the two upper surfaces rough; the outer distal part of the propodus is produced into a rounded tapering process which projects outside the dactyl, reinforcing this joint; the dactyl is stout, curved, tapering to a sharp curved point and armed on the concave lateral margin with a series of six or seven serrulate teeth.

The lateral margins of the ambulatories and in a less degree their dorsal surfaces, are furnished with long plumose setae.

CORALLOCARIS PERLATUS sp. nov.

(Fig. 8)

Type: Field No. 2728, an adult male and ovigerous female, also three ovigerous females and one male, Field No. 2716, Gonave Bay, Haiti, and are deposited in collections of the Department of Tropical Research of the New York Zoological Society.

Distribution: So far known only from the above cited stations in Gonave Bay, Haiti, as dwellers in sponges; the specimens taken appear to live a pair each in an isolated cavity of the sponge.

Name: The name refers to the beaded great chelipeds.

Technical Description: Animal slightly smaller than the average-size snapping shrimp, which it superficially resembles. Color in recently preserved formalined specimens opaque creamy. Great chela of the male exceeding in size the carapace; in the female nearly as long as carapace. Rostrum fully one-half as long as the remainder of the carapace, the tip of the apical spine projecting slightly beyond the distal margin of the third peduncular article of the antennae. The rostrum is laterally compressed, slightly arched proximally between the orbits and with the distal portion slightly curved downward, the apical spine directed straight forward. The superior margin is armed with eight to ten spines, including the apical spines. These spines are smaller proximally, increasing in length distally, the first spine being quite rudimentary, the fourth to eighth spines as a rule long, subequal, while the ninth and tenth spines are subequal, but a trifle shorter than those immediately preceding. All the rostral spines are acute, directed obliquely forward, the distal group forming a fan-like crest; the longer spines are of greater length than the width of the adjacent rostrum, in this respect differing decidedly from both *C. atlantica* Rathbun and *C. wilsoni* Hay and Shore. The rostrum arises from a thickened base in the extreme anterior portion of the carapace. The carapace is glabrous, rather soft, moderately compressed, armed with a strong, acute postorbital spine, directed forward and outward and slightly exceeding the

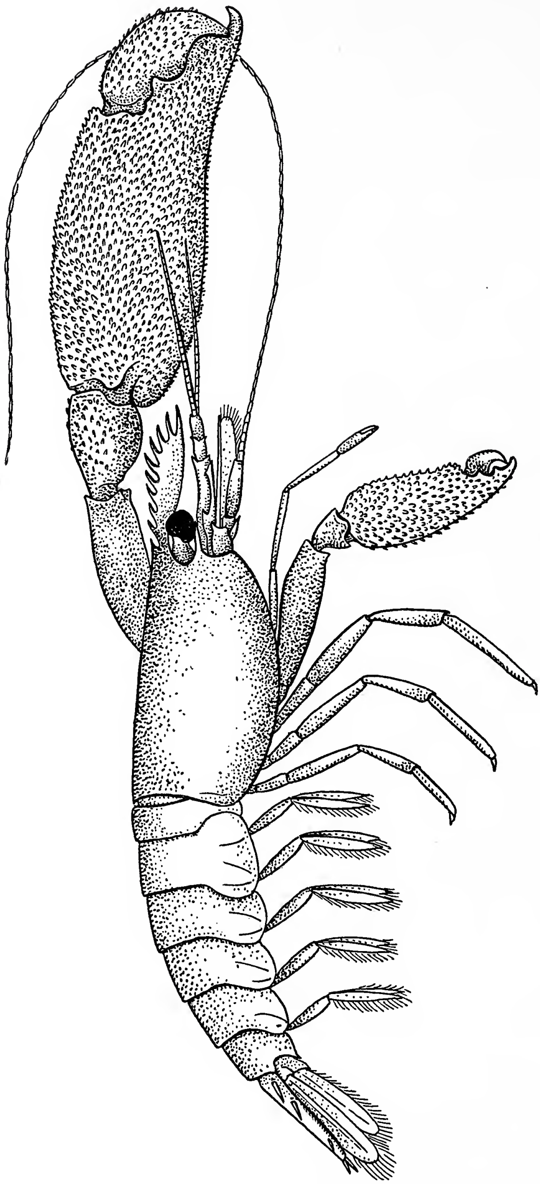

Fig. 8. *Corallocaris perlatus* Boone. Male, type × 3. Drawn by Helen Ziska.

length of the eyestalk. The antennulae have the basal article narrow, slightly concave on the upper surface, a little longer than the eye and with a spine at the outer distal angle; the second and third articles are short, cylindrical, subequal, reaching almost but not quite as far distally as do the rostrum and scaphocerite; the flagellum is biramose, the outer whip being shorter and much the thicker, itself bifurcating after the ninth thick article, the inner branches being the shorter and consisting of only seven small articles which have a horny brush of long fine setae; these setae are more sparsely spaced along the under side of the peduncle; the longer branch consists of about fourteen articles and is devoid of setae. The longer, slenderer whip which arises from the third peduncular article is about one and two-fifths times the length of the thicker inner branch, and does not bifurcate distally.

The eyes are large, the stalk stocky extending about as far as the third rostral spine; the cornea two-thirds as long as the stalk, spherical, terminate, black.

The antennae have the proximal joints short, the carpocerite slender, cylindrical, reaching as far forward as does the third peduncular article of the antennae; the flagellum slender, devoid of setae, consisting of approximately forty annulations and being about one and two-thirds times as long as the longest whip of the antennulae.

The abdomen is moderately compressed in the male, broader in the female, if extended not quite twice as long as the carapace, exclusive of rostrum. The epimeral plates of the first, second, and third plates are produced and broadly rounded, forming a capacious brood pouch in the female, the epimera of the fourth and fifth segments are less prominent but have the postlateral angle produced and rounded. The telson is almost twice as long as the sixth segment and is decidedly tapered, with the proximal width nearly twice that of the distal width. The terminal margin is evenly rounded and armed with four articulated spines, a slender submedian pair and an equally long but much thicker outer pair, one each at the outer lateral angle. In addition to these, there are three pairs of long, acute articulated spines on the dorsal surface, one pair near the base of the telson the second pair roughly one-third of the length from the base, and the third pair, approximately three-fourths of the length from the base. The caudal fan has a small peduncle, a broadly oval, cilated inner blade which extends the length of the telson a distance approximately equal to the length of the distal articulated spines of the telsonic margin. The outer blade is wider distally but a trifle shorter than the inner blade and with the distal margin more bluntly rounded, and a stocky acute subdistal spine at the outer lateral angle.

The first legs are extremely slender, almost linear, and very long, with the ischial and meral joints greatly elongated, the carpus two-thirds as long as the merus, the propodus about three-fifths as long as the carpus, of no greater diameter, weakly chelate, the fingers subequal, nearly straight, almost one-third of the total propodal length.

The second legs are conspicuously unequal in both sexes. The left one is normally the larger; in the male type it is approximately of as great size as the body appears with the telson bent under the body. In the female the unequality

is conspicuous but the great chela is only two-thirds the size of that of the associated male, while the body of the female is much stouter than that of the male. The male great cheliped has the merus compressed cylindrical when extended reaching beyond the body of the animal to about midway the rostrum, the carpus short, convex, narrowed proximally, dilated distally, the under surface produced to a narrowed ridge which terminates distally in a sharp tooth, the lower distal face excavate fitting upon the rounded end of the huge propodus. The propodus is very large, convex proximally, thick and high, cylindrical, more laterally compressed distally near the base of the finger but still quite thick, the propodal finger bent inward with the tip slightly upward curved and projecting beyond the tip of the hinged finger, the propodal finger has visible from the inner and outer faces a small triangulate subbasal tooth immediately beyond which it is concavely excavate for the reception of the huge blunt tooth of the hinged finger. The hinged finger is high, laminate with its curved triangulate tip closing inside the propodal finger, a short distance from the base of the latter. There is one large truncated tooth. The entire surfaces of the propodus, the propodal finger and the proximal part of the hinged finger are covered with numerous, short, conical, sharp spinose granules. These are visible to the unaided eye and form a conspicuous field-character. On the under side of the proximal part of the propodus these spines are arranged in regular transverse rows, giving them a brocaded or slightly corrugated appearance. The propodus and small cheliped of the male is by actual measurement two-fifths as long as that of the large one, but this measurement gives no true idea of actual disparity between the two, because the palm of the great chela is enormously dilated while that of the small cheliped is much less so, having a more laterally compressed aspect especially on the distal half of the palm and the fingers, which are slightly incurved; the fingers are short, subequal; almost the entire cutting edge of the upper finger forming a convex lobe which is separated from the acute finger tip and fits into the concavity of the lower finger, the tip of the latter closing between this convex lobe and the apex of the upper finger. The entire surface of the small cheliped is covered with spiny granules, as in the larger cheliped.

The third, fourth and fifth legs are similar in structure, successively decreasing in size and length in the order named. Each has the merus elongated and rather wide; the carpus only half so long and narrower, the propodus three-quarters as long as the merus, laterally compressed, tapering a little distally; the dactyl extremely short, rudimentary, curved, acute, its length scarcely greater than the width of the adjacent propodus.

The female type is carrying about 300-600 round, yellow eggs.

Remarks: The different rostral dentition of this species at once separates it from the other West Indian species, *C. atlantica* Rathbun 1901, which has only four rostral teeth in addition to the apical teeth. This was described from two small specimens, taken at "Fish Hawk" station 6079, off St. Thomas in 20-23 fms.

It is likewise distinguished from *C. wilsoni* Hay and Shore 1918, by the greater length of the rostrum, with a lesser number of teeth, which are differently arranged forming a fan-like crest in *C. perlatus;* the second chelae of *C. perlatus* are beaded with conical spines all over, while those of *C. wilsoni* are glabrous.

Alpheus platycheirus Boone

(Figs. 9 and 9a)

Type: The type was taken in 12 fathoms at Siguanea Bay, Isle of Pines by the Pawnee and is deposited in the collections of the Peabody Museum, Yale University.

Material Examined: A male and a female, from a loggerhead sponge, Port-au-Prince Bay, No. 2767, Haiti. One mutilated specimen from a fish stomach, captured in the same locality. The type was unfortunately badly mutilated in the dredge, hence the capture of three specimens, including both sexes, by Dr. Beebe, is a very welcome and important find. This species, with its exceedingly flat claw is one of the most peculiar of the sponge-dwelling shrimp.

Technical description: Animal compact, body subcylindrical, great cheliped extremely flat. Rostral tooth acute, spine-like, projecting beyond the ocular lobe and continuous posteriorly as a distinct carina for two-fifths of the length of the carapace and terminating posteriorly in a median tooth. Ocular lobes prominent, rounded anteriorly and elevated as hemiovoids dorsally, pigment strong, blackish. Carapace smooth, laterally compressed, 9 mm. long or about three-fourths the length of the great cheliped. Abdomen compressed, tapering, the second, third, fourth and sixth segments subequal, the first and fifth segments each slightly shorter than the others. The epimera are but little produced, the pleopoda long and heavily fringed. The first epimera are narrow and overlapped by the second which are moderately rounded, angulated at the posterolateral angle. The third, fourth and fifth segments are similarly produced posteriorly. The telson is one and two-fifths times as long as the sixth segment, narrow, the distal margin rounded and the lateral margin sinuate with a distinct curve about midway its length. There is a median longitudinal depression on the dorsal surface of the carapace; also two pairs of submedian articulated spines. The inner blade of the uropoda is oval, three-fifths as wide as the outer with a conspicuous median longitudinal carina from which there branches midway and almost at right angles, a short carina that reaches to the inner lateral margin. The wider outer blade has a transverse articulation separating the distal fourth of the blade from the proximal part which bears a definite longitudinal carina the greater part of its length. The transverse segmentation terminates in a distinct notch on the outer lateral margin.

The great cheliped has the propodus one-third longer than the carapace, the merus is strongly compressed laterally, a series of spinules along the inferior inner lateral margin; the carpus is short, cup-like, convex on the upper surface, the propodus is one-third longer than the carapace and extremely flat. The anterior lateral face is one-third as high in the median region as its total length; the dorsal and ventral margins are convergent proximally; the propodal finger is a continuation of this flat surface of the palm, but is very lightly depressed in the median area; the finger is long, tapering at the acuminate, upcurved point; on the proximal half of the cutting edge there is a large, suboval tooth which is deeply concave in the center; the distal third of the inner lateral margin of the tooth is

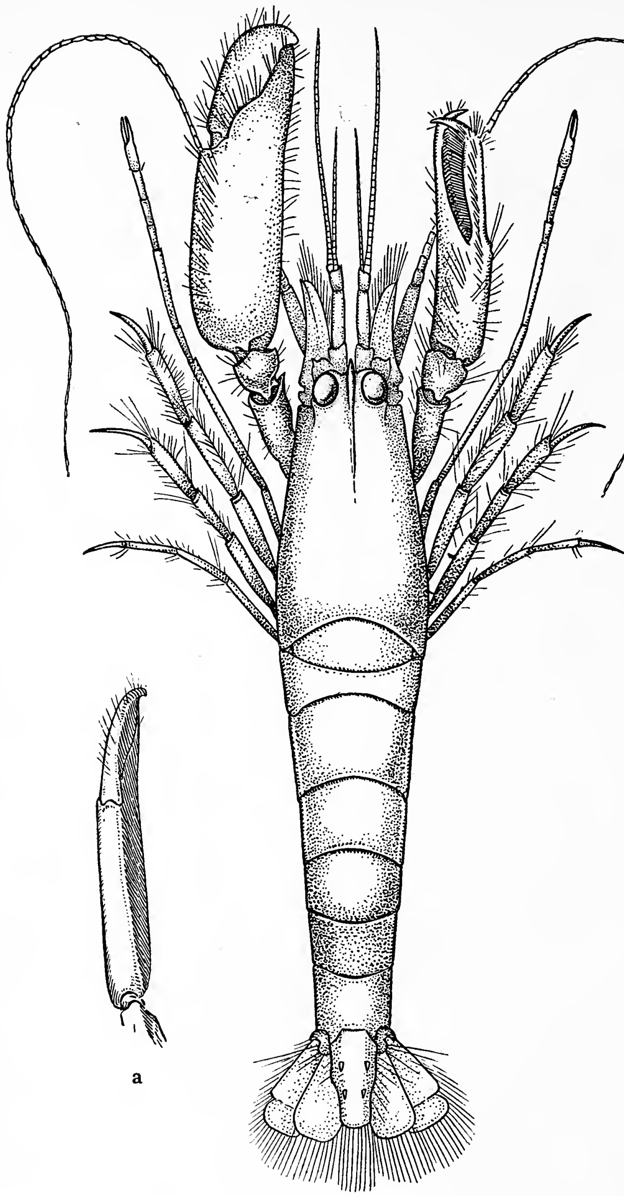

Fig. 9. *Alpheus platycheirus* Boone. × 3. Fig. 9a. Dorsolateral view of palm of great cheliped of same. Drawn by Helen Ziska.

lower than the remaining margin; the distal half of the cutting edge is a narrow grooved edge, which like the tip, is of a different color in the specimen from the remainder of the dactyl; the upper finger is similar to the lower one in length and in being laterally compressed, but differs in that it does not narrow distally; the cutting edge bears a sub-basal elliptical tooth, flat on the upper surface and fitting into the concavity of the opposing tooth of the propodal finger; the tooth of the upper finger is continuous distally with the stout, carinate, cutting edge of the distal half of the finger, which terminates in a slightly curved, rounded tip. The entire propodus, but especially on the dorsal and ventral edges and the distal half of the fingers, is set with unusually long, abundant setae. The small cheliped resembles the larger in general structure and in being strongly compressed laterally. It is shorter by about one-fourth of the length of the dactyl of the larger cheliped and it is only one-half as high as the large chela; the finger of the small chela is one and three-fifths times as long as the related palm, very slender, the cutting face flat, the tip tapering and curved, crossing upon the tip of the similar but slightly slenderer upper finger. There is a decided gape between the fingers which is equal in its median width to that of one finger, and is filled with a dense brush of long thick setae.

The second legs are very slender, the ischium greatly elongated, slightly exceeding the merus in length; the carpus is composed of five joints, of which the second is the longest, the first joint being four-fifths as long as the second; the third, fourth and fifth articles are subequal, each being one-half as long as the first article; the palm of the propodus is two-thirds as long as the distal carpal article and no thicker; the fingers are as long as the last carpal joint and very slender.

The third, fourth and fifth pairs of legs are moderately robust, of the proportions shown in the figure; the dactyli being notably curved, hook-like.

Synonymy: *Alpheus platycheirus* Boone, Bull. Bingham Oceanog. Coll. vol. 1, art. 2, p. 131, fig. 29, and fig. 30, 1927.

PARACERCEIS EDITHAE sp. nov.

(Fig. 10)

Type: The type and nine paratypes, including both sexes were collected at Gonave Bay, Haiti, and are deposited in collections of the Department of Tropical Research of the New York Zoological Society, Field No. 27240.

Distribution: Gonave Bay, Haiti.

Name: This exquisite isopod has been named for the artist, Mrs. Edith Thane.

Technical Description: Body about 5 mm. long in median line; decidedly convex from side to side. Head approximately three-fifths as long as its median width, with the frontal border rounded, produced to a median point and the posterolateral angles produced and entirely occupied by the large oval convex, composite eyes. The inner antennae are nearly as long as the outer pair, extending to nearly midway the epimeral margin of the second thoracic segment, while the

outer antennae extend to the posterior angle of the epimeral margin of the same segment.

The upper antennae are about five-sixths as long as the lower and consist of a long thick basal article, followed by a shorter thick article and a long slender

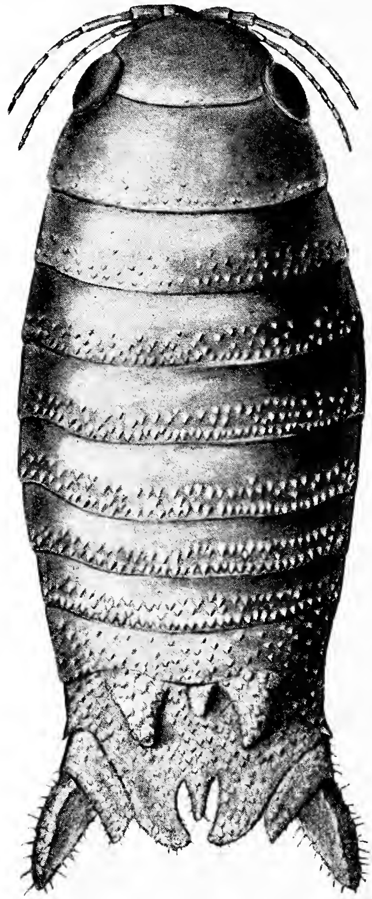

Fig. 10. Paracerceis edithae sp. nov. Type greatly enlarged. Drawn by Edith Thane.

third article, and flagellum composed of six small articles the distal two or three of which are set with tufts of setae on the distal upper margin.

The antennae have the three peduncular articles slender, elongate, the first subequal, the third a little longer, and a flagellum composed of ten fine tapering articles, the distal five or six of which are set with setae on their respective distal margins.

The first thoracic segment is a trifle longer than any of the others which are subequal. The anterolateral angles of the first segment are produced forward in acute processes which extend beneath the eyes to almost the anterior margin of the latter, the postlateral angles of this segment are similarly produced into acute processes which project backward to midway the epimeral margin of the second segment. The epimera of the second to the seventh segments inclusive are narrowed, curved, posteriorly directed with the angles rounded; the epimera of the fifth and sixth segments are more broadly rounded, that of the sixth segment being somewhat flaring and angulated, the epimera of the seventh segment is less protruding than that of the sixth and is widely rounded.

The abdomen consists of two segments; the proximal one is only two-thirds as long in the median line as the last thoracic segment but distinctly wider, the lateral region projects decidedly beyond that of the last thoracic segment and is produced posteriorly and widely, shallowly rounded. The distal segment has the anterior part moderately convex and produced on each side in the median lateral region into a very prominent large conical lobe; between these two lobes there is a smaller but well-developed conical subacute median tubercle; behind this tubercled area the distal part of the segment is produced into three processes, i.e., a median tooth which is slender, triangular, tapering, with the upper surface and base slightly convex, and the tip imperceptibly upcurved, on either side of this median tooth there is a subcrescentic sinus, narrowed inwardly and widened distally, and separating the median tooth from the larger paired, submedian processes. Each of these submedian processes has the inner lateral margin concave, the outer lateral margin convex and denticulate, while the distal margin is notched by a wide V. The fixed immovable branch of the uropoda is small with the distal margin rounded and extends less than half the length of the terminal abdominal segment; the movable outer branch is long, tapering, acuminate, flaring outward a little and strongly upcurved. There is a distinct row of microscopic granules across the posterior margin of the second, third and fourth thoracic segments. On the posterior margins the fifth segment bears two transverse rows of tubercles, one on the posterior margin and one just anterior to the posterior margin; the sixth segment bears two transverse rows of granules similar to those on the fifth segment, except that the granules are much stronger; the seventh thoracic segment also has two similar rows of granules, which are much stronger than those of the sixth segment; the posterior margin of the proximal abdominal segment is also very granulose; the distal abdominal segment has the paired conical tubercles very granulose; the surrounding region more sparsely and finely granulose; the distal margin of the telson and uropoda are denticulated by coarse granulations. Numerous fine setae are present on the dorsal surface of the carapace, these are interspersed among the granules and appear to be more abundant on the posterior margins of the telson and uropoda.

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ZOOLOGICA

SCIENTIFIC CONTRIBUTIONS OF THE NEW YORK ZOOLOGICAL SOCIETY

NOTES ON THE GILL-FINNED GOBY

Bathygobius soporator (Cuvier and Valenciennes)

By William Beebe, Sc.D.

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NOTES ON THE GILL-FINNED GOBY*

Bathygobius soporator (Cuvier and Valenciennes)

With an Explanation of the Specialized Pectoral Fin.

William Beebe, Sc.D.

OUTLINE

Introduction: For a space of six weeks from July to August, 1930, my deep-sea trawling engine was out of commission and my bathypelagic work temporarily at a standstill. The fish nearest at hand was *Bathygobius soporator* which was to be found in every tide-pool on the shores of Nonsuch.

I collected a few, and studied them both in aquaria and in their own haunts. The following notes sum up my observations on this most interesting fish.

Name and History: In 1837 Cuvier and Valenciennes gave the name *Gobius soporator* to a fish which M. Achard had brought from the island of Martinique in the West Indies. Forty-one years later Bleeker considered that this species was worthy of separate generic distinction and called it *Bathygobius*. A less appropriate title could hardly be imagined for this inhabitant of tide-pools and other shallow waters. The specific name is a Latinized translation of the term by which the native West Indians know this species.

*Contribution, New York Zoological Society Department of Tropical Research, No. 360.

In Bermuda, in common with several other related species, this goby is called, for no apparent reason, Molly Miller, Sheep's head Molly Miller and Black Joe. Elsewhere it is known as the Sleeper, Babosa, Amoreia, Mapo, Caiman, Oopu, Too-goo, Silk-finned Goby, etc.

Field Characters: This is a medium-sized Goby, with united ventral fins free from the abdomen; head depressed, body compressed posteriorly; *pectoral fins with upper rays free and filamentous.*

General Range: Reported to be cosmopolitan in the tropics, but intensive study will probably show considerable geographical speciation. In the western Atlantic it has been recorded from Bermuda, Charleston, Florida to Colon and the West Indies, south to Bahia and Rio Janeiro.

Occurrence in Bermuda: This is the commonest goby in the infrequent tide-pools, found sometimes on sand but generally on rocks. At low tide on August 20, 1930, a census of all tide-pools on the shores of Nonsuch showed one hundred and twenty-six fish; probably well below the actual number. In an isolated tide-pool on Cock Rock on August 24, there were twelve of these gobies, four of them over three inches in length. In shallow water observing from the diving helmet, I have seen this species as deep as two fathoms on sand.

Sociability: There is no schooling or concentrating of these fish other than the normal association which of necessity results from such a localized habitat. From three to seven fish are usually found in a tide-pool of good size, seldom more than one large one. Several times (six to be exact) I have changed marked individuals from one tide-pool to another, many yards away, and five out of the six times the transferred fish were found next day in their original pools. So there is apparently a definite habitat selection and a decided preference for a certain chosen spot. When crowded in an aquarium they will nip one another's tails, but I have never seen any evidence of serious attack in undisturbed individuals.

Viability: The viability of these gobies is remarkable, although only what might be expected from their habitat in life. A newly caught goby 43 mm. in standard length displaced 2 cc. of water. It was placed in a glass dish holding 50 cc. of salt water with a surface exposure of 60 by 90 mm., where it lived in apparently normal strength and activity for six full days. It then collapsed and could scarcely move or turn over. So

I removed it and found that the water had evaporated to 21 cc. At first the water barely covered the fish, while on the last day or two most of its back was out of water. The fish revived in a few minutes in a large aquarium.

Fresh water seems to make no difference to this fish. After three days in fresh water with only slight aeration, individuals of this species showed no symptoms of discomfort. The rate of breathing was quite normal.

One of my gobies recovered full health after three hours of accidental drying on the dust of a cement floor, and after its eyes, gills and skin were thoroughly dry and coated with all manner of débris.

General Form: The first glance shows that this goby is not built for continued speed or sustained activity of any kind. It has relinquished its ancestral heritage of motion in three planes of space and has struck bottom and remained there, paying the penalty of an unlovely rebalancing of its whole being and the resulting heaviness of general structure and form which characterizes terrestrial creatures as compared with those which inhabit the water and the air.

The general lateral outline of the body is as nearly an elongated rectangle as a fish can show. Anteriorly the body appears heavy and robust. The back slopes very slightly downward to the tail and the ventral profile is almost flat, a very evident adaptation for resting on the bottom. The head is rounded, the snout short and curved, merging halfway into the thick flat lips. The general lateral appearance is of a clumsy, awkward, inept species of fish.

The top view shows more shapeliness, the anterior half still thick and heavy, but the posterior tapering rapidly. The two views taken together reveal a vivid relation to the dominant activities in a two-plane life. There is little provision for up and down movements, but abundant adaptation in the narrow, laterally pliable peduncle, for quick left or right, forward or back twists, turns or darts.

From the top, the resemblance of the head to that of a frog is striking; the broad rounded mouth, the bulging eyes and the turgid jowls. The greatly swollen character of the opercles appears to be due to two dominant causes, first the necessity of lateral, not ventral movements in respiration, and the second, the need for an unusually strong, hence thick, operative musculature. These fish, in having to contend

with the smashing power of the waves and the tremendous pull and push of surging waters, could not avoid damage to any external delicate organs. The mouth is hence protected by great fleshy, yet deeply socketed lips. The eternal hydraulic pump which means life itself, avoids injury from the risks which stress of external force induces, by an over development of opercular muscles.

SIZE AND WEIGHT: Six inches is the maximum length of this species, and half that extent is a much more common size of adult individuals.

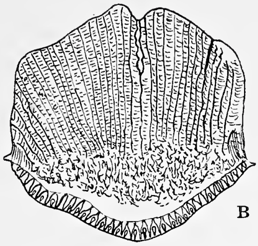
31 mm. (33 per cent)	.....	.8 grams (6 per cent)
51 mm. (55 per cent)	.....	2.5 grams (18 per cent)
79 mm. (85 per cent)	.....	8. grams (60 per cent)
93 mm. (100 per cent)	.....	13.5 grams (100 per cent)

The above table shows the relative percentages of length and weight.

SCALATION: In a goby of 21 mm. standard length the entire body is covered with scales except the head, the nape back to near the first dorsal, and the area around and behind the ventrals as far back as the anus. The scales bordering the clear nuchal area and between the pectorals and ventrals are very small, but normal in structure and in their moderately deciduous character. These soon give place to scales of average size. From the vertical of the first dorsal the scales increase in size steadily toward the tail, the largest being on the sides of the caudal peduncle.

In the 21 mm. specimen there are fourteen rows at the vertical of the first dorsal, and six rows at the tail. On one side of the fish I count 665 scales. Doubling this and including seventeen median ones, we have a total of 1347 scales on the entire fish. Their arrangement in longitudinal rows is as follows:

1st row, nape to 1st D—24.
2nd row, nape, nearly to end of 1st D—30.
3rd row, nape, to end of 1st D—44.
4th row, nape to caudal—43.
Remainder of nape scales—23.
5th row, end of nape to end of 2nd D—30.
6th row, end of nape almost to caudal—36.
7th row, top of P to C—36.
8th row, midline, P to C—35.



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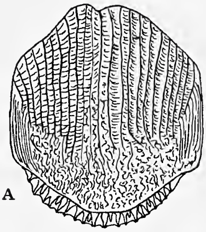

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Fig. 12. Typical scales of *Bathygobius soporator*. A—Midline scale of a 31 mm. fish; B—Midline scale of a 72 mm. fish.

9th row, P to C—38.
10th row, P almost to C—33.
11th row, P to caudal peduncle—55.
12th row, P to C—27.
Ventral area of small scales—180.
13th row, end of small scales to posterior end of V—17.
14th row, end of small scales to anterior end of V—12.
D line on caudal peduncle—7.
V line on caudal peduncle—10.

The scales are strongly ctenoid, probably a valuable asset in aiding the fish to retain its hold and resist the stress of breaking waves. They are remarkably uniform and vary chiefly in relative size and slightly in shape.

For illustration I have chosen a scale from two individuals, taken in each case from the 8th or mid-line row, the seventh scale from the caudal end. A is from a fish of 31 mm. standard length, B from one 72 mm. long.

	Standard Length	Scale Length	Scale Width	Length Ctenoid Spines
Specimen A..........	31 mm.	1.4 mm.	1.2 mm.	41 mm.
Specimen B..........	72 mm.	3.0 mm.	2.9 mm.	22 mm.

Specimen A: The exposed or posterior edge of the scale slopes backward 35° evenly above and below from an obtuse central angle. Along this side are 40 slender sharp teeth, with stout bases, pointing at right angles to their individual bases. An inferior tissue of skin reaches to their tips. The hidden or anterior edge of the scale has the same angles as the posterior edge but the center has a slight notch. The dorsal and ventral contour between the slopes of the other edges are

horizontal. From the anterior edge to half-way along the dorsal and ventral planes there extend twenty-three radii, horizontal centrally, but becoming slightly oblique above and below. These reach about three-fifths over the entire scale, giving place to an area of broken lines and irregular markings. Between each of the transverse lines are stout, fine, concave circuli, none of these quite reaching the radii themselves. On mid-scale there are about thirty of these before they dissolve into irregular hieroglyphics. Beyond the last dorsal and ventral transverse markings, the short circuli become lengthened into about ten lines which parallel the outer border of the scale.

Specimen B: The scale is much more rounded posteriorly, but with the flat dorsal and ventral contour and the anterior angles and notch as in Specimen A. The spines have increased to 74, and are longer and more slender. The increase has been by the intercalation of small spines between the larger ones, which seem to have no definite basal attachment. The larger teeth, whose bases connect with one another, represent the original ones, as they are forty-four in number.

The radii have increased to thirty-six, but nine of these are imperfect, absent at one or the other end. The circuli have remained as fine as before, but about doubled in number. The transparent skin on the entire exposed portion, about one-half of the whole scale, is sparsely covered with fine black chromatophores.

In the nuchal mid-line scales, lying just before the 1st D, the posterior line of spines is altogether lacking, the entire scale being occupied by about twenty radii and the intervening circuli.

On the side of the fish close behind the pectoral, the scales are much reduced in size, and the teeth are cut down to 21, a small number but all of full size and normal structure.

Pigmentation: The basis of the pigmentation in this goby is quite simple. A low power lens shows the transparent dermis of the living fish covered more or less solidly with a multitude of small, greyish-white chromatophores, circular, with fairly regular circumference. In the center of each is a small black dot—round and dense. The darkening of the light ground color is caused by the dendritic enlargement of this central black chromatophore. On many parts of the body the heart of the black spot is intense blue, and this is strong enough to show up brightly in certain liveries. When orange appears it is in the form

of very small round spots in the white border. If the black remains contracted and the orange chromatophores expand, the general effect is of a solid orange or golden area. In one dark phase the dominant color is green and this appears to result from a juxtaposition of the blue and the golden. After death the separate character of the large white areas is lost.

Usually, when the dark cells expand, they become dendritic, but on the cheeks they may enlarge into curious square or pentagonal outlines and remain firm all along the contours.

Color: Few fish show such radical color changes as the gobies and I believe it would be possible to make half a hundred slightly different paintings of a single individual. But there is an average mean—a usual livery which may be used as the basis of description. It is difficult of exact description, for the instant one of these gobies is caught or killed the entire pattern and visible pigmentation changes. The only safe way is to attract all the gobies of pool after pool with a bait of crushed chitons and then with a short focus glass to watch and record and compare every detail of the coloration.

In Bermuda specimens there are four well marked extremes of pattern and color, and these may be described and defined as follows:

Color phase A—Normal—Black and White.

Color phase B—Fear—Blue-Spotted, Dark Green.

Color phase C—Nocturnal—Banded.

Color phase D—Sand—White.

Color phase A, Normal: I call this the normal phase because it is the usual livery of the undisturbed gobies in the rocky tide-pools (not on the sand). In an aquarium, after a day or two, when they have become used to the new conditions they return to at least an approximation of this coloring.

In this phase there are about ten narrow lines of white, and ten of dusky gold extending down the whole body. The white is rather less connected but to the unaided eye, dominates the gold. This is because the gold is oxydized with very dilute, dendritic, brown chromatophores, which deaden the yellow and make it appear dark. The purity and sheen of the white produces a curious appearance of a series of ribs in high relief.

On this lateral background are three linear series of large dark

blotches, cut into more or less oval shapes by the white longitudinal lines. These gross markings extend from the back two-thirds down the sides, and on the peduncle become reduced to five or six round, dusky spots.

This pattern and coloring are all derived from the dermis. Aside from a few, small, scattered black dots, the scales are colorless. When a patch of these is removed the important chromatophores appear. The golden are interspersed with brown ones, the white are strengthened by a substratum of solid silver.

On the opercles the dark chromatophores are dominant, forming a solid background for numerous, small, round, white spots. There are three, large but indistinct dark blotches on the preopercle, and in some cases an irregular, dark, pale-bordered band extends from the eye to the upper limb of the pectoral.

The fins all show more or less distinct, but broken, bands of black and white, the anterior spine of the first and second dorsal being always sharply marked. Dark blotches may come and go on the lower cheeks and on the pectoral bases.

Color phase B—Fear: This is essentially a dark green pattern, and is assumed at moments of extreme fear. A goby usually changes very suddenly into this when dipped up roughly from its pool, or, when cornered, it attempts to leap from one pool to another. On making its escape after being thoroughly alarmed, the fish invariably seeks concealment in a crevice, a dark hollow, or among and in dark green seaweed. Hence this sudden shift of color is explicable by the speed and character of the change in environmental background. The shift is almost instantaneous, but the reverse is very gradual, probably from the slow dying down of the more violent emotion than from any physiological cause.

The general color of the head, body and fins is dark green, the head decidedly darker, while both dorsal fins show a wide margin of yellow. Over the head and body there appears an abundant scattering of small blue dots.

Color phase C—Nocturnal: The most common pattern and color assumed at night is a banded one wholly unlike any other extreme phase, although often shown in transitory light tints. It is frequently assumed when oxygen is lacking and the fish is feeling the need of fresh water. Looked at from above, the nape and snout are black, the rest of the head back to the first dorsal seal brown; then another black band and a brown

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Fig. 11. Color phases of *Bathygobius soporator*. A—Normal; B—Fear; C—Nocturnal; D—Sand; E—Front view of goby supported by the vacuum formed by the ventral fins. From a painting by Else Bostelmann.

band of equal width, followed by a narrow black, a white, and a brown band on the peduncle. The two broad black bands are bordered with a wide margin of white.

Color phase D—Sand: When on hot, sunlit sand, the gobies change again, this time bleaching out almost every dark marking, except very faint ones on the fins. When completely sand adapted the fish are absolutely invisible, their sessile position avoiding shadows, and their color exactly that of the grains of sand.

FINS: This fish, like most gobies is generously provided with fins, the eight separate structures being supported by one hundred and ten spines and rays. Unusual specialization is evident only in the four paired fins, the upper rays of the pectorals being free, delicate and soft, and the ventrals being joined together in a vacuum-making cup—typical of many species of the family.

Elsewhere this goby seems to show considerable variation in fin rays, but in sixteen Bermuda individuals measuring from 20 to 70 mm. in length, there is only a single instance of variation. This is in a fish 55 mm. long, in which there is an additional superior caudal spine, making eight. The corresponding ventral element is represented only by a merest dot of bone.

The very consistent fin count in Bermuda specimens is as follows:

Dorsal VI—I, 10
Anal I, 9
Caudal VII—17—VII
Pectoral 20
Ventral I, 5

RESPIRATION: When the goby is resting quietly and breathing normally, the respirations number about two every second. The movement brings into play all the bones of the mouth, jaws and throat. The mouth never closes, in fact its entire movement is very slight, much less than that in the average fish. The mouth opens, draws in water, then partly closes and the internal, labial, membrane veils close together while the opercles at the rear spread out laterally and draw the water back simultaneously with the closing down of the pliant branchiostegals over the skin back of the pectorals; the movements follow one another rapidly and smoothly.

Ordinarily this is the only respiratory movement, but when the

oxygen content gets low, in an aquarium or in an isolated, high-set, super-heated tide-pool, then the second line of breathing comes into play —the upper fourth of the pectorals, bearing the long, webless, soft rays and raylets, begins to wave back and forth. They move synchronously and are timed exactly to take advantage of the stream of water coming from the gill-openings. As the branchiostegals close down, ejecting the last mouthful of water, the pectoral gills move forward. When this process is in full swing the pectoral fins as a whole are raised and spread out laterally, but only the upper part—no more than a fourth of the entire fin, is in motion. I have seen it in play when the pectoral fins had to keep firm grip on a rock, and under such conditions the mobility of muscular movement and the sharp distinction between the actively waving part and the immobile lower section was very sharp and striking. The number of the free rays varies, but there may be as many as fourteen undivided secondary branches. Curiously enough these rays are less sensitive to touch than are the other, less specialized rays. Neither from direct observation in life, nor in microscopic observation do I find any confirmation of the tactile function which has been suggested by some authors—". . . les rayons supérieurs devenus crinoïdes servent d'organes du tact."

The gill-openings are admirably adapted for functioning in a tide-pool. Their complete opening is about the width of the muscular base of the pectoral and these apertures are placed close to that fin. As these fins are wholly lateral, it follows that the fish can flatten its head and thoracic region on the bottom of the pool without interfering with the full respiratory action.

Instead of simple tips to the rays of the remaining fins, we find that there are a multitude. To take the first coarse divisions, we find that a total of 89 fin rays shows a division into 456 tips. Individual fins are as follows:

Pectoral: 21 rays and 92 tips.
Ventral: 5 rays and 43 tips.
Second dorsal: 9½ rays and 41 tips.
Anal: 9½ rays and 54 tips.
Caudal: 17 rays and 91 tips.

Each of these tips has in turn a more minute subdivision into 4 to 8, and taking 6 as a fair average, we have 2736 distal, fingerlike, fleshy,

highly vascular projections, which apparently can function, when waved through the water, as a third respiratory reserve.

Thus the tips of all the rays of all the fins (except the first spiny dorsal) are branched and take up no bone stain. The significance of this was not apparent until I watched a goby for a long time in a small plate-glass box. Some time after he had begun to feel discomfort, when the pectoral gill-rays were working rapidly, I saw him begin to wave all the fins of the body—second-dorsal, anal, caudal, and even the ventrals swaying back and forth. The whole body waved sideways through a small arc. Only the first spiny dorsal was flattened and invisible. All the others were raised or expanded to their full limit. There seemed no doubt that the goby was helping out his over-worked gills with the sensitive tips of all the fins. When suspicious of my close approach the movement of the body ceased first, and later when much worried, he stopped the vibrating of the pectoral rays. Just before the fish turned rapidly to escape, the gill movement itself ceased.

The value of these auxiliary breathing organs in enabling the fish to endure temporary imprisoning in an unoxygenated pool is beyond estimate. It would make all the difference in a question of existence or nonexistence in many places, and the fish probably owes its great abundance and wide distribution to this ability, affording such a great advantage over related forms which must depend solely upon the usual respiratory apparatus.

Membranous Labyrinth and Otoliths: The two membranous labyrinths of *Bathygobius soporator* are similar in general construction to those of other teleostean fishes, consisting of sacculus, utriculus, and semicircular canals, but in a few respects are highly specialized. They, together with the contained otoliths, are well developed, but the cranial cavity, in fact, the whole skull, is relatively shallow. Therefore, they must in some way be compressed vertically to fit in the small available space. This has been accomplished by an actual folding over of the entire organ, in much the same way that a sheet of writing paper is folded to fit its envelope.

The utriculus, instead of being dorsal to the sacculus, which is the normal position, is ventral to it, and is connected with it by a membranous canal. The semicircular canals issue from the utriculus and execute their arcs close to and about the sacculus, not in the cartilage and bone

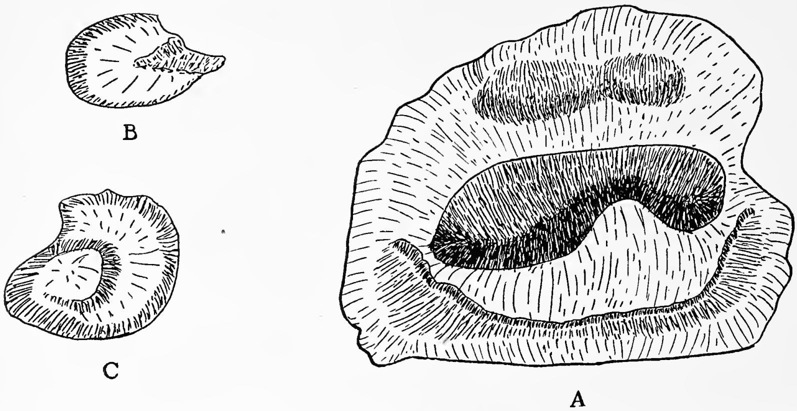

Fig. 13. Otoliths of *Bathygobius soporator*. A—Sagitta. B—Asteriscus; C—Lapillus.

above it. The horizontal semicircular canal completely encircles the sacculus and sagitta.

The two sacculi and their otoliths, the sagittae and asterisci, are contained in cup-like depressions, called the *saccular cavities,* which occupy the sides of the cranial cavity posteriorly, reaching quite from top to bottom. They slant backward, inward, and downward, following the inward obliquity of the cranial cavity.

There are three otoliths contained in each membranous labyrinth: a sagitta, an asteriscus, and a lapillus. The sagitta, which is by far the largest and best developed of the three, has its inner side slightly convex and its outer side correspondingly concave. It rests upright, or perhaps with a slight outward slant in the sacculus, its outline anteriorly fitting closely the oval contour of the saccular cavity.

The asteriscus, the smallest of the three otoliths, is contained in a blind pouch—the cochlea—extending posteriorly from the sacculus. It is oval in shape and is characterized by a definite anterior rostrum and a sulcus. This is remarkable, because in most teleosts the asteriscus is rather characterless.

The lapillus is about one-third again as large as the asteriscus and is round and thick in general contour. It is situated in the utriculus and is therefore ventral to and slightly inside of the sagitta.

The dissection and drawings of the otoliths of this fish were made by Mr. Patten Jackson. The painting of the color phases is the work of Else Bostelmann.

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ZOOLOGICA

SCIENTIFIC CONTRIBUTIONS OF THE
NEW YORK ZOOLOGICAL SOCIETY

STIMULATION BY ADRENALIN OF THE LUMINESCENCE OF DEEP-SEA FISH AND THE CHEMICAL ASPECTS OF THE LUMINESCENCE OF DEEP-SEA SHRIMP

By E. Newton Harvey
Princeton University

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STIMULATION BY ADRENALIN OF THE LUMINESCENCE OF DEEP-SEA FISH*

By E. Newton Harvey
Princeton University

Collecting deep sea animals in good living condition is very difficult. Whether affected by change in pressure, or temperature, or asphyxiation in the bottles at the end of the nets, it is unfortunately true that most deep sea forms come up quite dead and motionless. Occasionally they are living.

Through the great kindness of Dr. William Beebe, Director of the Bermuda Oceanographic Expedition of the New York Zoological Society, I have recently had an opportunity of studying the luminescence of a large deep sea fish, *Echiostoma ctenobarba,* two specimens of which, about one foot long, were brought into the laboratory in iced sea water in the living condition. They were caught at eight hundred fathoms.

In *Echiostoma* there is a prominent cheek organ and two rows of large photophores along the ventral and lateral walls besides numerous minute photophores scattered over practically the whole body including the dorsal surface. The cheek organ is partially pink in life and was observed to flash with a decidedly bluish luminescence when the fish was handled, especially when lifted out of the sea water. No other luminescence of any kind could be noted, however, despite the fact that the fish was squeezed and twisted to stimulate it strongly. A hypodermic needle was then inserted but no luminescence additional to that of the cheek organ appeared. However, when a little adrenalin (1:1000 in physiological salt) was injected with the hypodermic into the side about one-third toward the tail end, there immediately appeared a yellowish luminescence of photophores locally, near the point of injection and soon practically all of the photophores of the fish were luminescing with a yellowish moderately intense continuous glow. This lasted a few minutes and then went out and could not be excited again by rubbing or handling but appeared as before on a second, third and fourth injection of adrenalin. The last injection was of ten minims and excited all or-

*Contribution, New York Zoological Society Department of Tropical Research, No. 361.

gans and also the pectoral and ventral fins. There is no doubt of the luminescence of these fins despite the fact that they do not possess any marked organs. No luminescence was observed in the tail, anal fins, long pectoral rays, or barbel on lower jaw. The cheek organ flashed at intervals after adrenalin injection but did not change in rhythm or in any noticeable way. The flashing of this organ is not due to unscreening of a continuously luminous surface. The light appears and disappears on the organ itself and for this reason we may presume that *Echiostoma* is self luminous and does not harbor luminous bacteria as is the case in the Dutch East Indian fish, *Photoblepharon* and *Anomalops,* which also possess cheek organs.[1]

There is no doubt of the stimulating action of adrenalin on these photophores. The observations add a second example of luminous fishes known to be excited to luminescence by adrenalin. The first was the California toad-fish, *Porichthys,* described by Greene and Greene.[2] It is a surface form, difficult to stimulate in other ways but which gives a brilliant long lasting glow of its eight hundred odd photophores after injection of adrenalin. The fire-fly also glows continuously and brightly after adrenalin injection.[3]

As the photophores of *Porichthys* receive a very sparse nerve supply, Greene believes that adrenalin acts directly on the photogenic cells. I can state, however, that it does not cause luminescence of the worm, *Chaetopterus,* or of hydroids. In the fire-fly there is considerable evidence of a nerve-muscle mechanism controlling the flash.[4] Studies of the photophore nerve supply of deep sea fish would be very valuable and are much needed.

It should be mentioned that adrenalin is not a stimulant for light production after a fish has been dead some time. Other dead deep sea fish, and even a feebly moving *Linophryne arborifera* could not be made to light by injecting adrenalin. For the physiologist, the great problem is to get the material in good living condition. It is my belief that increased temperature is the chief lethal factor. When we remember that temperatures a mile deep are four to five degrees Centigrade while the

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[1] *Harvey, E. N.* The Production of Light by the Fishes. Photoblepharon and Anomalops. Pub. No. 312 Carnegie Institution Washington, p. 43, 1922. Natural History *25,* 353, 1925.

[2] *Greene, C. W.* and *Greene, H. H.* Phosphorescence of Porichthys notatus, the California Singing Fish. Amer. Jour. Physiol., *70,* 500, 1924.

[3] *Creighton, W. S.* The Effect of Adrenalin on the Luminescence of Fire-flies. Science, *63,* 600, 1926.

[4] *Dahlgren, U.* The Production of Light by Animals. Jour. Franklin Inst. March and May, 1917.

surface water is twenty-five degrees Centigrade, and also that it takes over an hour to haul in the nets, we realize the unfavorable conditions to which these deep sea forms are subject. Perhaps we are lucky to observe luminescence under any circumstances.

Zoologica, Vol. XII, No. 7

CHEMICAL ASPECTS OF
THE LUMINESCENCE OF DEEP-SEA SHRIMP*

By E. Newton Harvey
Princeton University

It is convenient to group all luminous organisms into two great classes, those which produce a steady continuous light quite independent of stimulation, the luminous bacteria and the fungi, and those whose luminescence appears only on agitation or stimulation of some kind, including all the others. These may again be divided into forms whose light is intracellular like *Noctiluca* and the fire-fly, and those with extracellular luminescence, forms which secrete a luminous slime or which throw a fluid from glands into the sea water in which they live. Many medusae and the ostracod crustacean, *Cypridina,* belong in the latter group.

Such forms often store up a very large amount of luminous material which they pour out, surrounding themselves with a barrage of fire behind which we may suppose they make their escape from the jaws of some predacious enemy. The most notable and spectacular animal of this class is a small squid, *Heteroteuthis dispar,* found in the Mediterranean and especially at Messina, where I have had the opportunity of studying them. Most of the ink sac has become transformed into a luminous gland. When disturbed, the glowing secretion is shot out thru the siphon as a cloud of luminescence that surrounds the animal. Attacking fish would be subjected to a veritable bombardment of liquid fire quite as startling if not as dangerous as any developed during the war. It is almost paradoxical to find an organ developed for producing the very blackest material, suddenly transformed into one manufacturing not only a clear fluid but a fluid actually shining with its own light.

Such a mechanism of defence must be quite effective, for several other creatures have appropriated the idea. One of these is the deep sea shrimp or prawn, *Systellaspis.* Such forms were first described by Alcock[1] and observed by Beebe[2] during the "Arcturus Ad-

*Contribution, New York Zoological Society Department of Tropical Research, No. 362.
[1] *Alcock, A.* A Naturalist in Indian Seas, p. 134 1902.
[2] *Beebe, W.* The Arcturus Adventure 1927.

venture". Through the kindness of Dr. Beebe, I have recently had an opportunity of making some observations on the chemistry of luminescence in these forms, which have been obtained quite regularly in the tow nets from 600-800 fathoms, about 10 miles south of Nonesuch Island, Bermuda. The shrimp is about 1½ in. long, bright red in color, with a well spiked rostrum, very long antennae and a row of black dots along the sides. These dots are luminous organs although I have never seen light coming from them.

When brought to the surface and placed in iced sea water, since they come from depths where the temperature is about 5 C., they live for several hours, and with well dark adapted eyes one can see that this sea water is aglow with their luminescent secretion, the light lasting for some time. Touch the shrimp with a rod and immediately a cloud of bluish luminescent secretion is shot out from glands near the mouth, and is carried by convection currents thru the sea water.[3]

The luminescence of all organisms is the result of a slow burning or oxidation of a definite compound luciferin, in the presence of an enzyme luciferase. This was first proven to be the case by Dubois in 1886 in the large West Indian elaterid beetle, *Pyrophorus,* later in the mollusc, *Phelus dactylus,* and since then I have found these bodies in lampyrid fireflies, the ostracod crustacean, *Cypridina,* the worm, *Odontosyllis,* and Hickling has described them in the fish, *Malacocephalus laevis.*[4] Curiously enough it is not possible to demonstrate luciferin and luciferase in many of the 40 odd orders of animals containing luminous forms. As the opportunity has appeared I have been studying this point over a period of fifteen years, and table 1 shows the organisms tested and the group to which they belong.[5] Of special interest is the question as to whether the luciferin of one species will react with the luciferase of another. It is not possible to obtain simultaneously all the luminous animals that one would like to test but the ostracod, *Cypridina,* can be dried and its power of luminescence retained indefinitely (at least over a period of 12 years). light appearing whenever the dried animals are moistened. Table 1 shows also how other organisms react with *Cypridina* luciferin and luciferase.

[3]For histology of the organs see Dahlgren, U. The Production of Light by Animals. Journ. Franklin Inst. June 1917.

[4]For Chemistry of luminescence see Harvey, E. N., The Nature of Animal Light 1920; Recent Advances in Bioluminescence. Physiological Reviews *4,* 639, 1924. Bioluminescence. Bull. Nat. Research Council. No. 59, p50, 1927.

[5]*Harvey, E. N.* Additional Data on the Specificity of Luciferin and Luciferase, together with a general survey of this reaction. Am. J. Physiol. *77,* 548, 1926.

The preparation of luciferase and luciferin solutions is very simple. The former is obtained by merely making a cold water extract of the luminous organ, when both luciferin and luciferase dissolve and the luciferin oxidized with luminescence in a short time, leaving the luciferase (an enzyme) behind. Like all enzymes, luciferase is destroyed on boiling, whereas luciferin is not. Consequently luciferin is prepared by making a hot water extract of the luminous organ and cooling. This luciferin solution is quite dark but when mixed with luciferase, also dark, will again produce light.

It was found that *Systellaspis* luciferin mixed with *Systellaspis* luciferase would give a good luminescence, whereas *Systellaspis* luciferin mixed with *Cypridina* luciferase produced no light, nor would *Systellaspis* luciferase give light with *Cypridina* luciferin. This is quite in line with all the previous evidence I have been collecting[5], namely, that the luciferin-luciferase reaction is specific, that luciferin will not react with luciferase of other species belonging to a different group. However, the case of *Systellaspis* is of especial interest, sinse its luminescence is bluish and looks exactly like that of *Cypridina*, and the two forms are Crustacea, fairly closely related. It is the first time I have had the opportunity of testing two orders within the same class.

Only if luminous animals are very closely related, will the luciferin of one species react with the luciferase of another, as two genera of fire-flies or two genera of ostracods. In this case an interesting experiment can be carried out where the luminescence of the two species differs in color, as in fire-flies of the genera *Photinus* (reddish luminescence) and *Photuris* (yellowish luminescence). Intermixing luciferin and luciferase of these genera shows that the color of the resulting luminescence is not intermediate but is that of the fire-fly supplying the *luciferase*. This must mean that luciferase is the source of the light. From this and other evidence I have come to the conclusion that the energy for luminescence comes from the oxidation of luciferin.[4] The luciferase plays two roles:—(1) that of an enzyme, accelerating the oxidation of luciferin. (2) to supply molecules which can easily pick up the energy set free in oxidation. Such molecules the chemist call "excited molecules" and their excess energy can be liberated as radiation which we see as the luminescence of the animal. The color (wave-length) of the radiation will depend on the specific chemical configuration of the luciferase mole-

cules, which differ in different species and is so different in different groups that excitation cannot occur at all.

Thus, *Systellaspis* has supplied a very necessary link in our chain of evidence concerning the luciferin-luciferase reaction and I express my sincere thanks to Dr. Beebe, Director of the Bermuda Oceanographic Expedition of the New York Zoological Society for making it possible to obtain these unusual forms.

TABLE I

Group	*Species*	*Place*	*Luciferin-Luciferase reaction*	*Reaction with Cypridina luciferin and luciferase*	*Reported by*
BACTERIA	*Bacillus fisheri*	Princeton	—	—	Harvey
	Photobacterium phosphorescens	Woods Hole	—	—	Harvey
	Photobacterium javanese	Java	+	not tried	Gerretsen
FUNGI	*Panus stipticus*	Woods Hole	—	—	Harvey
SPONGES	*Grantia*	Friday Harbor	—	not tried	Harvey
RADIOLARIA	*Collozoum inerme*	Naples	—	—	Harvey
	Thalassicola nucleata	Naples	—	—	Harvey
CYSTOFLAGELLATES	*Noctiluca miliaris*	Japan	—	—	Harvey
MEDUSAE	*Aequorea forskala*	Friday Harbor	—	—	Harvey
	Mitrocoma cellularia	Friday Harbor	—	—	Harvey
	Pelagia noctiluca	Naples	—	—	Harvey
PENNATULIDS	*Pennatula phosphorea*	Naples	—	—	Harvey
	Cavernularia haberi	Japan	—	—	Harvey
	Ptylosarcus sp. ?	Friday Harbor	—	—	Harvey
CTENOPHORES	*Bolina sp. ?*	Friday Harbor	—	—	Harvey
	Mnemiopsis Leidyi	Woods Hole	—	—	Harvey
	Beroe ovata	Naples	—	—	Harvey
	Eucharis multicornis	Naples	—	—	Harvey
OPHIURIANS	*Amphiura squamata*	Naples	—	—	Harvey
ANNELIDS	*Odontosyllis phosphorea*	Bermuda	+	—	Harvey
	Tomopteris helgolandica	Plymouth	—	—	Harvey
	Polycirrus caliendrium	Plymouth	—	—	Harvey
	Chaetopterus variopedatus	Woods Hole	—	—	Harvey
	Harmithoe imbricata	St. Andrews, N.B.	—	—	Harvey
	Acholoe astericola	Naples	—	—	Harvey
	Misroscolex phosphorea	Naples	—	—	Harvey
OSTRACODS	*Cypridina hilgendorfii*	Japan	+		Harvey Kanda
	Pyrocypris sp. ?	Java	+	+	Harvey
	Cypripina sp. ?	Jamaica, B. W. I.	+	+	Harvey
COPEPODS	*Metridium sp. ?*	Naples	—	—	Harvey
SCHIZOPODS	*Meganyctiphanes norvegica*	St. Andrews, N.B.	—	—	Harvey
DECAPODS	*Acanthephyra sp. ?*	Bermuda	+	—	Harvey
MYRIAPODS	*Geophilus sp. ?*	Java	—*	not tried	Harvey
INSECTS	*Pyrophorus noctiluca*	Cuba	+	not tried	Dubois Harvey
	Luciola viticollis	Japan	+	—	Harvey
	Photinus pyralis	Princeton	+	not tried	Harvey
	Photuris pennsylvanica	Princeton	+	not tried	Harvey
LAMELLIBRANCHS	*Pholas dactylus*	Mediterranean & Plymouth	+	—	Dubois Harvey
CEPHALOPODS	*Watasenia scintillans*	Japan	—	not tried	Harvey
	Heteroteuthis dispar	Messina	—	—	Harvey
ASCIDIANS	*Pyrosoma sp. ?*	Monaco	—	—	Harvey
BALANOGLOSSIDS	*Ptychodera sp. ?*	Bermuda	—	—	Harvey
	Balanoglossus minutus	Naples	—	—	Harvey
FISH	*Photoblepharon palpebratus***	Banda Island	—	—	Harvey
	*Anamalops katoptron***	Banda Island	—	—	Harvey
	*Monacentris japonica***	Japan	—	not tried	Harvey
	Malacocephalus laevis	England	+	not tried	Hickling

*Dilute solutions.

**Contain luminous bacteria.

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NEW TEREBELLID ANNELIDS

THELEPUS HAITIENSIS and TEREBELLA HIATA

Two New Species From Haiti.

By A. L. Treadwell,
Vassar College.

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NEW TEREBELLID ANNELIDS

THELEPUS HAITIENSIS and TEREBELLA HIATA*

Two New Species From Haiti.

By A. L. Treadwell,
Vassar College.

(Fig. 14)

Through the courtesy of Director Beebe the polychaetous annelids collected on the 1927 expedition of the New York Zoological Society to Haiti were submitted to me for examination. While most of the material was made up of old species, two are new, and their description follows.

Thelepus haitiensis, sp. nov.

Collected at Station 27418. The type is in the collections of the New York Zoological Society.

The type is 85 mm. long and contains about 80 somites but is incomplete posteriorly. The prostomial width is 2 mm. From the anterior end the body rapidly increases in width as far as the region of somite 15 Somites immediately behind this point are smaller than somite 15 and at somite 38 there is an abrupt narrowing, the diameter from here to the posterior end showing only a very slight decrease. The upper lip is rather heavy and smooth, having a recurved margin and longitudinal lines on its inner face. A transverse band forms the lower boundary of the mouth. Behind this is a broader band, its width equalling about one-half of its length, the ends curving so as to enclose and cover over the transverse band above mentioned. There is no trace of eye spots. The tentacles are of varying sizes, the largest relatively very heavy. All are grooved longitudinally.

There are three pairs of gills on somites 2, 3 and 4. Each gill arises as a transverse basal ridge whose free edge is prolonged into a large number of fine filaments smaller than any tentacles, and all having a peculiar translucent appearance. A space equal in width to about that of one quarter of the gill-base, separates the gill of one side from that of the

*Contribution, New York Zoological Society Department of Tropical Research, No. 363.

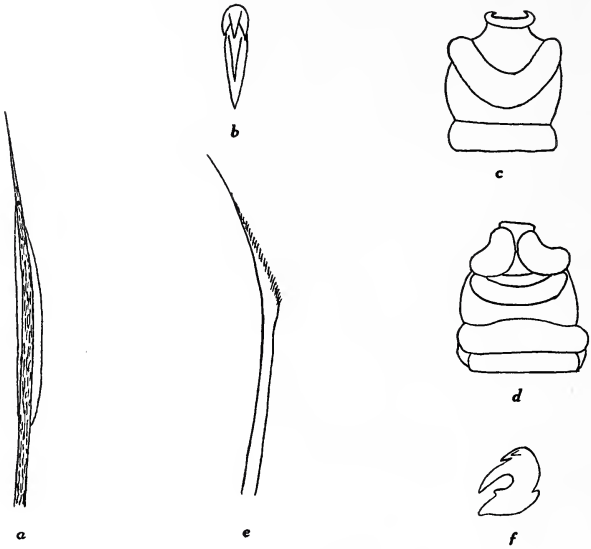

Fig. 14. A—Seta of *Thelepus haitiensis* x 250. B—Uncinus of *Thelepus haitiensis* x 250. C—Anterior end of *Terebella hiata*, dorsal view, x 10. D—Anterior end of *Terebella hiata*, ventral view, x 10. E—Seta of *Terebella hiata* x 250. F.—Uncinus of *Terebella hiata* x 250

other. In length and number of filaments the first gill is larger than the second and the second larger than the third. The ventral shields are most prominent anteriorly, less so toward the posterior end, the median furrow is distinct and each shield more or less wrinkled on its margins.

The first setae are on the third somite, while uncini begin on somite five. The setae are all slender, bilimbate (Fig. 14a), widen a little toward the end and terminate in a sharp point. The uncini are in a single row in each uncinigerous somite, (Fig. 14b). Each uncinus has a powerful hook, with two or three smaller hooks at the apex. Both setae and uncini extend to the posterior end of the body and are similar in character throughout.

TEREBELLA HIATA, sp. nov.

Collected at Station 27289. The type is in the collections of the New York Zoological Society.

The type is 80 mm. long with a prostomial width of 1½ mm. Body measurements in terebellids are deceptive because through mus-

cular contractions or through the action of preserving fluids the soft bodies of these annelids are usually distorted. In the type as it appears after preservation the width at the eighth somite is 4 mm. and this width is approximately maintained as far back as somite 22. Posterior to this point, the body narrows decidedly and the pygidium is not more than 0.25 mm. wide.

The tentacles are long and heavy and deeply grooved longitudinally. They arise from a broad basal plate which extends posteriorly over the first somite (Fig. 14c). Dorsally the upper lip seems rather thin, but ventrally it is thicker and bends around so that (Fig. 14d) it appears as a sausage-shaped lobe on either side of the mouth, the two lobes almost meeting in the mid-ventral line. The lower lip is small. There are no eye spots visible. The first somite is about as long as the two following somites taken together, later ones increase slightly in length but owing to obvious distortions no definite rule can be given as to these variations. There are 14 ventral shields, increasing in length but decreasing in width, from in front posteriorly.

There are three pairs of gills on somites 2, 5 and 8. The third pair are more than twice as long as the first, the second intermediate between these. Each gill arises by a stout basal stalk which divides in an irregularly dichotomous fashion to end in a dense tuft of short branches.

The simple setae begin on somite 4 and probably occur in all somites though I was unable to demonstrate them in the last 3 mm. of the body. They have stout shafts. The apical region is bent nearly at right angles, drawn out into a sharp point and toothed along the edge (Fig. 14e). The apex of this flattened portion is often curved into a different plane from that of the main part. The uncini are sometimes in one, sometimes in two, rows. Each (Fig. 14f) has a stout hook with a smaller apical one, and much smaller ones on either side of this. Only one of these is figured.

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ZOOLOGICA

SCIENTIFIC CONTRIBUTIONS OF THE
NEW YORK ZOOLOGICAL SOCIETY

NEW SPECIES OF FISH FROM THE WEST INDIES

BY WILLIAM BEEBE AND GLORIA HOLLISTER

VOLUME XII. NUMBER 9

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NEW SPECIES OF FISH FROM THE WEST INDIES[1]

By William Beebe and Gloria Hollister

Long-barbelled Flyingfish

Cypselurus antarei sp. nov.

(Fig. 15)

Type: *and only specimen, Antares Expedition Number 6. June 30, 1932. At 2 P. M. flew on board Yacht Antares, in 21° 50′ No. Lat. and 63° 32′ West Long., about two hundred miles north of Sombrero, B. W. I.*

Measurements: Total length 85 mm.; Standard length 71 mm.; Depth 14 (5); Head 19 (3.7); Eye 6 (3); Snout 4 (4.7); Dorsal 13; Anal 9; Pectoral length 45 (1.5); Pelvic length 28 (2.5); Barbel length 73, reaching to end of body (lower jaw being 2 mm. in advance of upper).

Color: Steel blue above, light below, changing to silvery; vertical fins clear; pectorals pale at base, blackening toward tips; distal four-fifths of pelvics black.

Barbel: The barbel of this fish is single, extremely soft and delicate, tapering very gradually from its base on the lower lip to the spider-web-like tip. It is attached around the entire curve of the mandible and is continued on each side into a rounded flap. The outer edges of the two flaps are joined by membrane to the outer sides of the barbel so that when it is extended to the full, backward, there is a very broad, rounded area of curved tissue (the hollow enclosing the lower jaw and chin), which rather abruptly flattens out into the wide, slightly curved ribbon of the barbel.

This is jet black, studded with minute blue dots, except down the center which is paler. Beneath, the central area widens rapidly until its fleshy white has replaced almost all the black pigment, but the black of the upper side holds strongly to the very tip.

[1] Contribution, New York Zoological Society, Department of Tropical Research, No. 410.

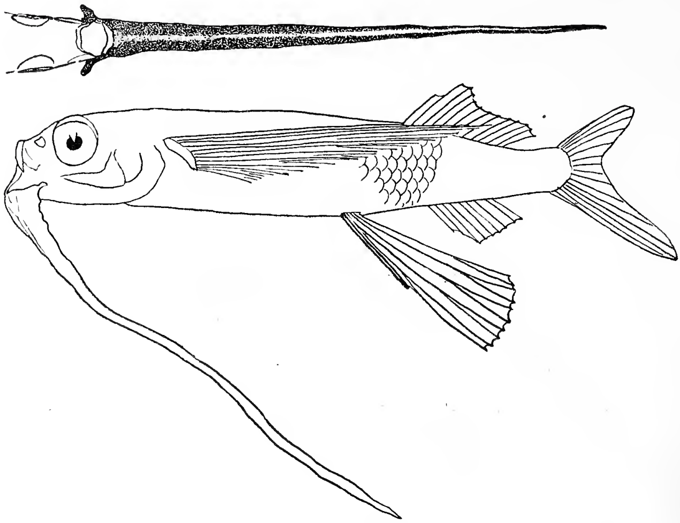

Fig. 15. Long-barbelled Flyingfish, *Cypselurus antarei* sp. nov. The upper figure represents the anterior side of the barbel.
Drawing by Helen Tee-Van

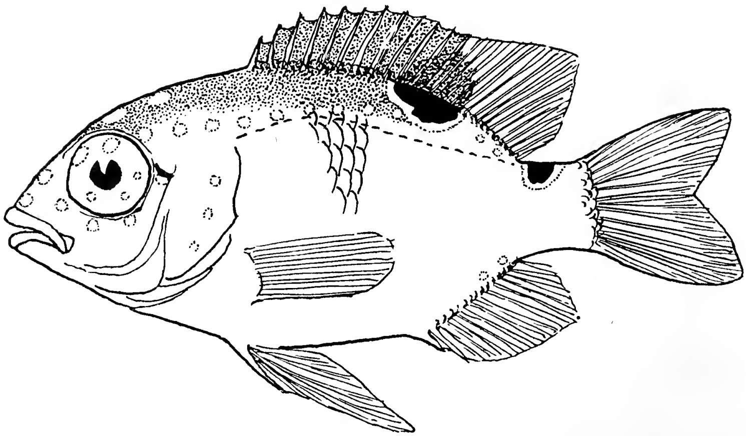

Fig. 16. Scarlet-backed Demoiselle, *Eupomacentrus rubridorsalis* sp. nov.
Drawing by Helen Tee-Van

Compared with Nichols and Breder's *Cypselurus monroei*, this fish is 3 instead of 2 inches long; the barbel is single, not double; tissue-like, not fleshy; flattened, not fluted; as long as the body, not half as long, and it arises from the lip, not the chin.

Scarlet-backed Demoiselle

A new and abundant species of this group

EUPOMACENTRUS RUBRIDORSALIS SP. NOV.

(Fig. 16)

DISCUSSION: On the twelfth of August, 1930, while swimming along the north-east shore of Nonsuch, Bermuda, and looking down through a water-glass, I saw a brightly colored Demoiselle quite new to me. The following day, in company with Hollister and Crouch I again found the fish, two of them this time, near the same place, about a coral boulder. I tried in vain to capture them on three successive days and after scrutinizing them carefully I finally exploded a dynamite cap near them, but could find no trace and never saw them again. I dictated the details of pattern and coloration for a colored plate and forgot about them.

In July 1932, on the Antares in the West Indies, Hollister and I found this species to be very common in certain of the islands, and have named and described it as follows:

EUPOMACENTRUS RUBRIDORSALIS, sp. nov.

TYPE: *Antares Number 97; Fifteenth Expedition of the Department of Tropical Research of the New York Zoological Society; July 9th, 1932. Taken near shore in Chatham Bay, Union Island, Grenadines, B. W. I. Standard length 15.5 mm. A second specimen, Antares Number 145, was taken July 18th, 1932, in a tidepool in Deep Bay, Antigua. In length, measurements, pattern and coloration the two are identical.*

FIELD CHARACTERS: A typical Demoiselle in shape and habits; dark blue in general, with top of head, upper sides and spinous dorsal fin scarlet; two ocelli, black with turquoise border, one between

spinous and soft dorsal, and the other on upper aspect of caudal peduncle.

MEASUREMENTS AND COUNTS: Total length 17.8 mm.; Standard length 15.5 mm.; Depth 7.5 (2); Head 6 (2.58); Eye 2.2 (2.7); Snout 1.7 (3.5); Maxillary 1.7 (3.5); Pectoral length 4.6; Pelvic length 4.8; Dorsal count XII, 16; Anal count II, 13; Scales 29; Gill-rakers 8.

DESCRIPTION: Body dark blue (bluish gray after death); upper head and back above lateral line scarlet, thickly flecked with black; dorsal spines solid scarlet; dorsal rays and anal dusky at base, the remainder translucent bluish; very large ocellus, larger than eye, at junction of dorsal spines and rays, consisting of a large, jet-black center, surrounded with a ring of turquoise, with a narrow outer frame of black. A series of turquoise spots, framed with black, scattered over head and body as follows: 2 between upper lip and upper eye; 5 surrounding eye; 3 on opercle; 8 in a line, from eye almost to first ocellus; 3 large ones on each side of top of head, one obliquely above and in front of eye, one above eye, one on nape; 5 in iris, upper two large and stronger and connecting the loral and dorsal lines; 2 at base of posterior dorsal rays; 2 at base of posterior anal rays.

There is a second ocellus, one-third as large as the dorsal one, on the upper peduncle; Iris, aside from the turquoise spots, golden.

DISTRIBUTION: The two which I saw but could not capture in Bermuda are the only ones ever recorded from that island. The colored plate which I had drawn from memory had in no particular to be changed when compared with a fresh specimen from the West Indies. The following is the distribution of this new species and of its most closely related known form, as we observed it in the West Indies:

	E. rubridorsalis	*E. leucostictus*
Union Island, Grenadines (Type locality).......	Abundant	Absent
Tobago Cays, Grenadines....................	Common	Several seen
Antigua..................................	Common	Common
Barbuda..................................	Common	Common
Haiti....................................	Absent	Abundant
Bermuda..................................	Two seen	Abundant

Having no dynamite caps, and owing to the absence of tide-pools in the Leeward Islands, I was able to capture only two specimens of this new species, which however, although from different islands, three hundred miles apart, are identical in measurements, pattern and coloration.

We saw many, from two to three inches in length, always in pairs, and, as in other species of this genus, constantly on the defensive, attacking and driving away all intruders, large and small, from their chosen home.

There is no doubt that this is an adult coloration, distinctly marked, not a permanent color phase, not grading, sexually, emotionally or ontogenetically into any other phase. Both in haunts, habits, size and general pattern *rubridorsalis* offers an interesting comparison with *leucostictus*.

Grenada Sponge Goby

GOBIOSOMA CHANCEI SP. NOV.

(Fig. 17)

TYPE: *And only specimen, Antares Expedition, New York Zoological Society, No. 22. July 4th, 1932. Taken from a large, yellow sponge on a shallow reef in St. George's Bay, Grenada, B. W. I.*

MEASUREMENTS: Total length 47 mm.; Standard length 39 mm.; Depth 9 (4.3); Head 10.7 (3.6); Eye 2.5 (4.3); Snout 1.7 (6.3); Maxillary 4 (2.7); Dorsal VII–12; Anal 10.

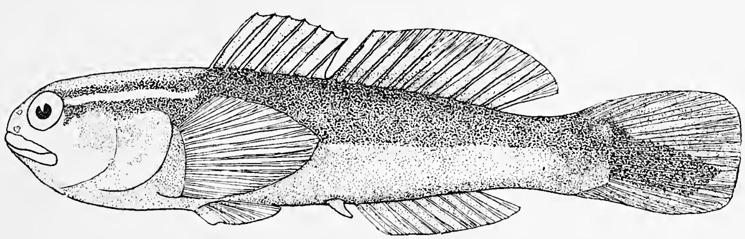

Fig. 17. Grenada Sponge Goby, *Gobiosoma chancei* sp. nov.
Drawing by Helen Tee-Van

COLOR: General body dark brown below, darkening into black above; entire lower center of caudal fin black; lips, chin and throat bright lemon yellow; iris greenish; a strong yellow line extending from the top of each eye, back along each side of the head, ending abruptly midway between the beginning of the first dorsal fin and the upper base of the pectoral. This line is bounded widely on each side with jet black.

Comparison: This species is closest to *Gobiosoma horsti* Metzelaar, differing chiefly in pattern, color and the relative positions of all the fins, as well as the absence of scales on the caudal peduncle. Briefly expressed, in *Gobiosoma chancei* the colored lateral line is short, not long, and it is yellow, not blue; the first dorsal fin arises behind, not before the pectoral base; the second dorsal arises in front of, not behind the anus; the pelvics are well developed, not minute, and they arise behind, not in front of the pectorals. There is no trace of scales, even on the peduncle or along the sides.

This species is named in honor of Colonel Edwin M. Chance to whose interest and generosity this West Indian expedition was due.

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ZOOLOGICA

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CLEARING AND DYEING FISH FOR BONE STUDY

By Gloria Hollister

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CLEARING AND DYEING FISH FOR BONE STUDY*

BY GLORIA HOLLISTER

OUTLINE

INTRDOUCTION

(Figs. 18-21 incl.)

During my work in the Department of Tropical Research of the New York Zoological Society in connection with the shallow-water and deep-sea fishes of Bermuda I have prepared, with clearing fluids and bone stain, approximately three thousand transparent specimens in order to facilitate the study of the skeleton. A necessary requisite was a rapid and, at the same time, adequate technique which would render the material ready for immediate study. I have had to adapt old techniques not only to fish in general but to individual species. An entirely new improvement is the use of ultra-violet light. (Hollister, 1932).

*Contribution, New York Zoological Society, Department of Tropical Research Number 444.

This work, in the Department of Tropical Research, began at Kartabo, British Guiana in 1922 when Dr. Beebe made many transparencies of embryo birds, bats, frogs, and lizards.

While at Columbia University in 1924 and 1925 I studied and experimented with various methods and prepared a series of human embryos, small mammals, chicks, and snake embryos. Since 1927 I have continued to develop a technique especially for fish, both in our field laboratory at Nonsuch Island, Bermuda, and at the Zoological Park in New York City.

This paper is in answer to many requests from interested workers for details and new adaptations.

I take this opportunity to thank for their cooperation Dr. William Beebe, Dr. H. J. Conn, Dr. W. K. Gregory, Dr. A. Pollister, and Dr. R. M. Strong.

Technique

Material and fixing: The use of distilled water in the preparation of all solutions and dyes is advisable. It is absolutely necessary with solutions of alizarin.

The best cleared preparations of small and medium sized fish result from fresh specimens that have had no preliminary fixing. If the tissues should become too soft in the beginning of the clearing process, add increased amounts of 70 per cent alcohol to the potassium hydroxide solution to control this condition. Fix large, fleshy specimens in 70 per cent alcohol for several days.

When it is necessary to keep specimens for any prolonged length of time before running them through the clearing process, the least injurious preservative to the bony tissues is alcohol, which reacts equally well with delicate deep-sea fish and tough shallow water forms. Fixing in 70 per cent alcohol is, in one way, an advantageous preliminary step because it helps to remove green and blue colors from the skin. But, better than any fluid, is ultra-violet light which extracts all colors, even black pigment. Specimens should be irradiated after the staining, along with the clearing.

The use of formalin is dangerous because of the decalcifying action of formic acid on the bony tissues. If for any reason formalin must be

used, it seems less harmful in its acid form than after it has been neutralized.

It is advisable to puncture the sides of the fish in several places with a fine needle before attempting to dye or clear specimens having tough, fibrous flesh, such, for example, as found in the Gobiidae and Blennidae. The removal of scales from large specimens will hasten the penetration of the dye and the clearing of the tissues.

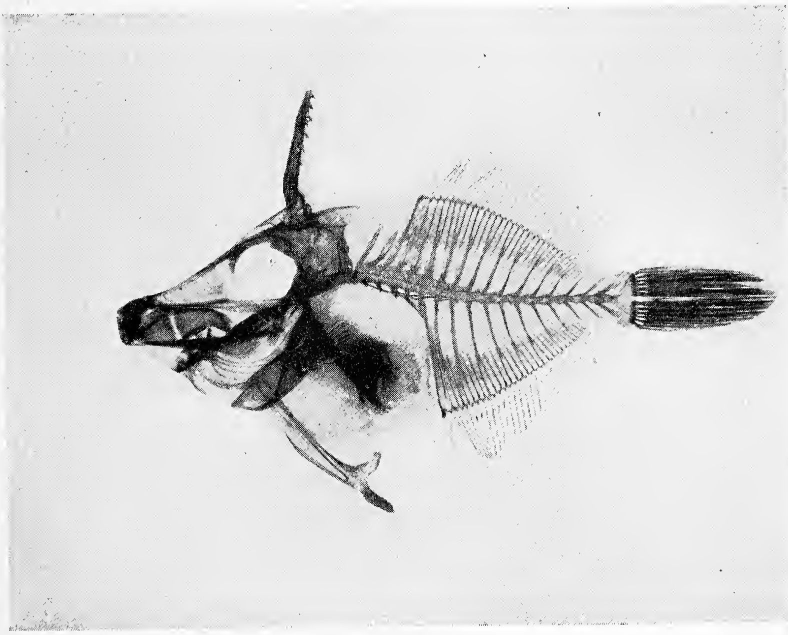

Fig. 18. *Monacanthus ciliatus* (Mitchill), showing every detail of bone clearly etched in red in a transparent body. The mechanism for depressing and raising the dorsal trigger spine can be demonstrated.

Alizarin

Brief history of alizarin: The earliest record was published in 1581 by Laevinius Lemnius, who mentioned in De Miracules Occultis Naturae that madder root had the property of being a vital dye for bone. Over a century and a half later, in 1736, John Belchier (Phil. Trans. Royal Society of London. 1735-36, Vol. 39 Page. 287) re-established this fact and experimented with the properties of madder

root by feeding it to animals. In 1868 Grabe and Liebeman first produced alizarin synthetically. It is now widely used in the form of its soluble salt, Alizarin Red S, Alizarin S, Alizarin Sodium Monosulfonate, and Alizarin Monosulphonate.

There has been a great deal of confusion caused by manufacturers giving their particular alizarin product a slightly different title with no formula to guide the biologist and experimenting zoologist. All these alizarins react alike with bone and are apparently alike in chemical formula.

Dyes used: There are several alizarin stains on the market which include Alizarin Red S, Alizarin S, Alizarin Sodium Monosulphonate, and Alizarin Monosulphonate. In addition to these are the following which have been used also by the author with repeated excellent results.—Alizarinsulfosaur Natron Grubler, Alizarin Sodium Sulphonate Eimer and Amend. According to Schultz and Julius all these dyes have the formula $C_{14}H_7O_7SNa$.

Alizarin is soluble in water and alcohol and it is an acid dye in an alkaline solution and a vital stain for bone. It belongs to the oxyquinone group of biological dyes.

Preparation of alizarin dye:

Alizarin, saturated solution in:—	
Glacial Acetic Acid c.p., 50 per cent	5 cc
Glycerine c.p., white	10 cc
Chloral Hydrate crystals, c.p., 1 per cent sol.	60 cc

The staining qualities of alizarin, made in the usual saturated solution in alcohol, is less permanent and the results more variable than when this formula, without alcohol, is used.

The addition of acetic acid in the dye solution counteracts partially the discoloration of the soft tissues by alizarin and facilitates clearing.

Keep materials for making alizarin dye solution in ordinary room temperature. Colder temperatures are detrimental.

Preparation of alizarin dye in staining solution:

Alizarin dye	1 cc
Potassium hydroxide, 1 or 2 per cent	1,000 cc

Alizarin dye is misible in dilute and concentrated solutions of potassium hydroxide prepared from white sticks, U.S.P., with distilled water. When tap water is used a flocculent suspension of the dye often results.

Alizarin dye should not be mixed in volumes less than 500 cc of potassium hydroxide. A violet-purple color as shown in Ridgway's Color Standards gives excellent staining reesults. If the bones of delicate specimens are to be stained, such as species which will not withstand much time immersed in potassium hydroxide, good staining results from using alizarin in a solution of potassium hydroxide with a high percentage of pure glycerine.

Make up staining solution with materials at ordinary room temperature. Colder temperatures are detrimental.

Use of staining solution: Place specimen in the staining solution immediately after a bath in weak potassium hydroxide, 1 to 4 per cent, which is the first step in the clearing process. The length of time to keep specimens in this preliminary bath of KOH and in the staining solution varies according to the size of the specimens,—whether the tissues are delicate or tough, and the amount of ossification in the skeleton. Careful observation must be made of the progress of each individual. For example, a delicate deep-sea specimen, *Sternoptyx diaphana,* 8 mm in length and previously fixed in 3 per cent formalin, was stained in six hours, and completely cleared and ready to be photographed and studied in less than twenty-four hours. But a tough shallow-water eel, *Gymnothorax moringa,* 285 mm in length and previously fixed in 3 per cent formalin, took six days to stain and over six months to clear.

It is important to immerse specimens in volumes of 200 cc or more of the alizarin staining solution.

Use staining solution at ordinary room temperature. Colder temperatures are detrimental.

Alizarin and bone: Calcium salts absorb alizarin according to the amount of accumulation in the developing bone of young and maturing fish. In large, shallow-water fish, where bone is dense and penetration of the dye is slow, it is often necessary to keep adding alizarin to the potassium hydroxide until no more dye is taken up and the solution remains its original color. In some deep-sea fish, especially the Isospondylids, certain parts of the skeleton, such as the fins, take

up only a trace of alizarin, and often none. These little known fish are always prepared with a control specimen.

Otoliths do not react to alizarin. Stained otoliths have never been observed in hundreds of specimens prepared, including shallow water and deep-sea forms from Bermuda, Hudson Gorge, and the Pacific. According to Signor Bercighi, of the Florence Museum of Palaeontology, otoliths are 94.87 per cent calcium carbonate, with only .35 per cent calcium phosphate which latter is the chief constituent of bone. The analysis

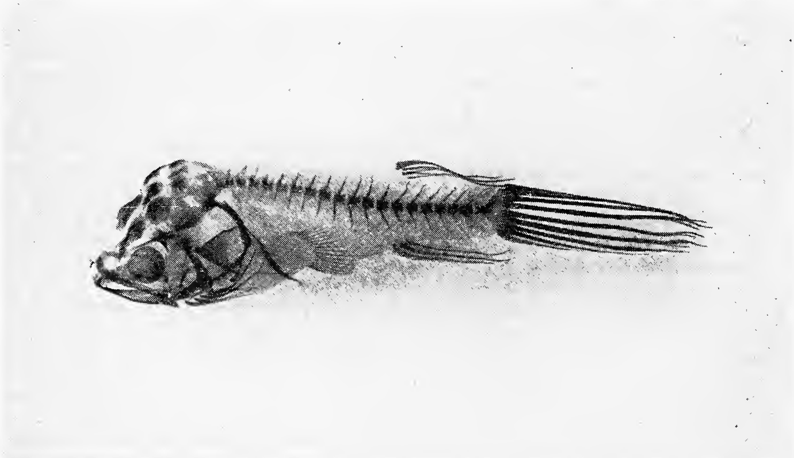

Fig. 19. *Haplophryne hudsonius* Beebe. Through the dermal balloon-like covering of the body (15 mm standard length) the exact number of hitherto obscure fin rays, teeth and delicate illicium are distinct.

of bone shows its major constituent to be calcium phosphate with a small amount of calcium carbonate. Human bone is 85 per cent calcium phosphate and only 10 per cent calcium carbonate.

The vertebrae of eels, pikes, salmon, and cod have 32.46, 38.70, 36.64, and 57.65 per cent respectively of calcium phosphate, and 3.64, 14.30, 1.01, and 4.81 per cent of calcium carbonate. (Animal Chemistry with Reference to the Physiology and Pathology of Man. By J. Franz Simon 1846.)

These facts show a certain correlation concerning the chemical affinity of alizarin and calcium phosphate of bone and also the apparent in-

sufficiency of calcium phosphate to absorb alizarin in certain parts of deep-sea fish skeletons.

In our collection there are specimens that were stained with alizarin ten years ago. Some of these preparations have been kept in the dark and others in the light and there is no evidence that the skeletons have lost any of their original color tone.

Clearing process

Clearing in conjunction with alizarin stain, has been tried with several oils, glycerine, sodium hydroxide, and potassium hydroxide. The most effective and harmless solutions are glycerine, and potassium hydroxide used separately and in per cents varying in strength with the kind of tissues to be cleared.

The most transparent and the most perfect preparations have resulted from immersing specimens in a pure dilute solution of KOH for a short time only. Prepare KOH from white sticks U.S.P. I have found it important, especially when the tissues are delicate, to immerse the specimens in a weak solution of KOH, 1 to 4 per cent, with a large percentage of pure glycerine early in the clearing process. In general, the addition of at least 40 parts of glycerine to the KOH, immediately after the removal of the specimen from the alizarin solution, gives excellent results. The most effective time to use the KOH without glycerine is immediately before and after the specimens are immersed in alizarin solution. The length of time in the KOH must be determined entirely by the size and the character of the specimen to be cleared, and its reaction and constant change. In the first step of using KOH before the alizarin solution, the specimens should be transferred to the alizarin as soon as the tissues show signs of clearing. After staining is complete, transfer specimens to a bath of weak potassium hydroxide just long enough to remove most of the alizarin from the tissues, then change to a solution of part KOH and part glycerine, as mentioned before. Use from 1 to 4 per cent, ordinarily, and up to 20 per cent for a short time only with large, tough, stubborn individuals.

Individual variation in clearing is very noticeable even in fish of the same size, and each specimen must be watched and the solution varied according to individual changes and progress.

After specimens are removed from the alizarin solution to the potas-

sium hydroxide clearing solution, ultra-violet light from an alpine sun lamp hastens the clearing perceptibly. Irradiation with ultra-violet can continue, if necessary, while the specimens are run up gradually into pure glycerine which is the final step. (Mall's solution is not satisfactory with fish. F. P. Mall, 1906.)

Ultra-violet light

Uses for decoloration and depigmentation: Instead of acids and bleaching fluids to remove pigment and excess alizarin from the

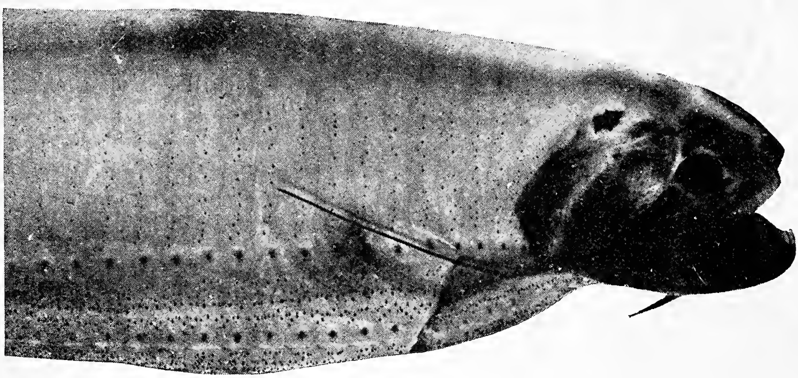

Fig. 20. A jet black deep sea fish, *Echiostoma ctenobarba* Parr, after irradiation, showing the number and arrangement of minute skin photophores which are almost indistinguishable until the black pigment is bleached before the final clearing.

flesh, ultra-violet light from an alpine sun lamp has been used with success for several years. It is doubly valuable because, along with its power to bleach, it speeds up the clearing of the tissues and often makes possible immediate study of prepared material.

During a certain phase of the clearing process, sunlight is a necessary agent to extract or bleach pigment from the tissues. Many times just when the specimens had reached this critical stage, a prolonged spell of sunless days would make progress in depigmentation impossible. In the absence of the sun's rays I experimented with incubator heat and bleaching agents, such as hydrogen peroxide, ammonium hydroxide, and various acids. For some time a controlled substitute for the rays of the sun was sought. Finally, exposing the specimens to ultra-violet rays

was tried. This is the only treatment which, without damaging the specimens, will extract the black pigment from deep-sea fish and render the tissues crystal clear with every detail of bone visible. Good results were had in combination with several solutions but by far the best was weak sodium or potassium hydroxide.

The great convenience of having the essence of sunlight under control in the laboratory ready for use when the specimens need bleaching cannot be overestimated.

Use ultra-violet immediately after removing specimens from alizarin staining solution and for as long as necessary to thoroughly bleach and clear.

Sulfuric and hydrochloric acids are dangerous because they attack not only the dye in the bones but the bones themselves. Also, ammonium hydroxide is much too potent for bleaching deep-sea fish and most shallow water fish. Many specimens became opaque and the tissues swollen and flaky when immersed in this fluid. Acetone, to remove fat, is injurious and not necessary when ultra-violet is used.

Permanent preservation

The preservation of cleared and alizarin stained specimens is permanent when they are kept in chemically pure white glycerine with a small thymol crystal. Thymol is vital to prevent mould if specimens are to be kept in a warm temperature. Glycerine should be renewed with the slightest indication of discoloration.

Another very important factor in the preservation of cleared specimens is the use of glass or rubber stoppers instead of cork. After a short time cork discolors the glycerine which in turn affects the tissues of the specimens, turning them dark brown.

Specimens with controls have been kept in the light and in the dark for experimental purposes with no apparent difference. Indirect sunlight does not seem to have any affect, but in order to be certain of no further change in completed preparations our collection is kept in semi-darkness.

Anatomical study

Value of cleared and stained specimens: The most important value of cleared specimens is the elimination of dissection and with the

possibility of injury, derangement, and loss of bones and organs. Cleared specimens that have been stained for bone with alizarin are not only valuable for a detailed study of the skeleton, but for a study of the various organs with their structural relationships. The following characters are some of those of which the study is greatly simplified in cleared specimens.

External: The delicate devolepment of barbels, or filaments on the head, and especially the tentacles in certain deep-sea fishes.

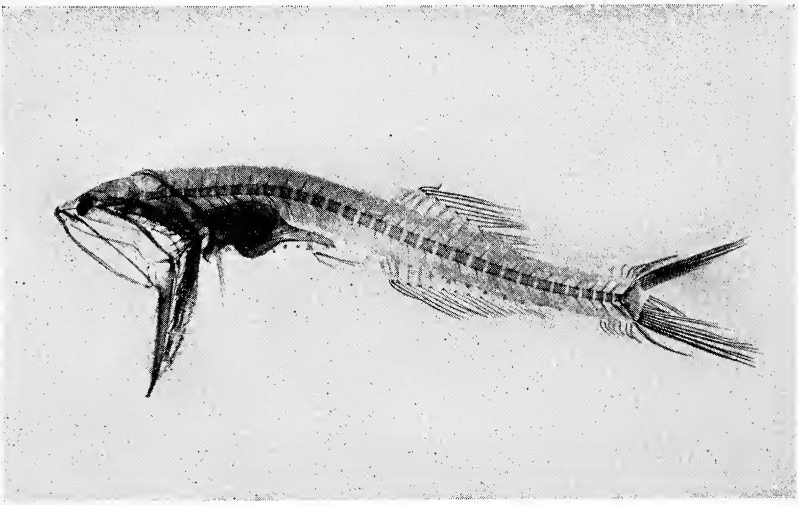

Fig. 21. *Cyclothone microdon* Günther, showing besides the skeleton, the shape of the alimentary canal system and food contents thus eliminating the need for dissection.

The accurate count of spines and soft rays in the paired and median fins even when not composed of bone. It has been found in many cases that the shorter spines and rays are hidden completely, and visible only when the flesh is transparent. In certain deep-sea fishes the fins are submerged in membrane which makes recognition of the rays impossible.

The course and intricate structure of the lateral line is traced more easily.

The photophores, their structure, number, arrangement and distribution in the skin and fins, some being visible in no other way.

Identification of the type of scales; whether placoid, ganoid, cycloid, ctenoid and the specialization of the lateral line scales. Growth striae are easily traced when stained with alizarin. *Dolichopteryx* was considered scaleless until stained and cleared.

INTERNAL: The number and development of teeth, and their attachment, whether implanted in sockets of the jaw bone, or ankylosed with it, or imbedded in the mucous membrane. The presence of enamel covering the dentine is indicated by remaining uncolored by alizarin.

The shape of the stomach, whether prolonged into a blind pouch, or bulbous, or leading directly into the intestine.

The food content of the stomach can be identified often without dissection.

The presence of eggs can often be determined.

Otoliths, which have never been observed to stain with alizarin, are easily located, standing out in contrast to the red skull bones. The sagitta is always evident and often the capillus and asteriscus.

Development of cartilage and bone and areas of deposition.

Delicate structures such as the details of the anterior dorsal spines of the trigger fish, and the migration of the eye of the flounder with the change in the skull bones.

SUMMARY OF TECHNIQUE

1. Fix large specimens in 70 per cent alcohol.
2. Bath in distilled water, few minutes.
3. Bath in potassium hydroxide, KOH, 1 to 4 per cent according to size of specimen and quality of tissues. Length of time according to individual. Prepare KOH from white sticks U.S.P.
4. Alizarin dye solution in potassium hydroxide, KOH, of 1 to 4 per cent. KOH per cent and length of time according to individual.
5. Potassium hydroxide, KOH, 1 to 20 per cent with or without pure glycerine, according to individual. Irradiation with ultra-violet light.
6. Irradiation with ultra-violet light and specimen in potassium hydroxide, KOH, with 40 per cent glycerine. Length of time according to the individual.

7. Potassium hydroxide, KOH, decreasing amounts with increasing amounts of pure glycerine, and ultra-violet light if still necessary. Length of time for each change according to individual progress.

8. Chemically pure, white glycerine with thymol in rubber or glass topped container.

Bibliography

These few references are restricted to techniques of potassium hydroxide, and potassium hydroxide with alizarin, in an attempt to simplify the literature.

It is interesting to note that Schultze mentions Beale as the first to realize the value of potash and glycerine for clearing. Schultze, however, was the first to set forth a definite adequate technique in the use of these solutions.

Potassium hydroxide without dye

Beale, Lionel S.
1858 King's College, London.
Dr. Beale's Archives of Medicine, No. 11, 1858.
On Making Transparent Tissues more Opaque, and Opaque Tissues more Transparent.
Material; Human Embryos.
Mentions value of glycerine, also alcohol with caustic soda to make tissues transparent. Prepared first human embryo in 1853, clearing it in alcohol with caustic soda.

Schultze, Oscar
1897 Professor at Würzburg Universität.
Anat. Anzeiger, Vol. 13. April, 1897.
Verhandlungen der Anatomischen Gesellschaft. Pages 3-5.
Ueber Herstellung und Conservirung durchsichtiger Embryonen zum Studium der Skeletbildung.
Material; Human Embryos.
In the above reference the technique is stated in greater detail than in the following reference which is often given.
Gundriss der Entwicklungsgeschichte des Menchen und der Säugethiere. 1897. Page 459.
Material; Human Embryos.

MALL, FRANKLIN P.
1906 Johns Hopkins.
The American Journal of Anatomy.
Vol. 5 1906, No. 4; pages 433-458.
On Ossification Centers in Human Embryos Less Than One Hundred Days Old.
Material; Human Embryos.
Mall is said to be the first to introduce the Schultze method into America.
Mall's technique is slightly modified by using weaker solutions.

STRONG, REUBEN MYRON
1925 Loyola University School of Medicine, Chicago.
The American Journal of Anatomy.
Vol. 36 1925, pages 313-355.
The Order, Time and Rate of Ossification of the Albino Rat Skeleton.
Material; Rats.
Mall's modification of Schultze's technique.

POTASSIUM HYDROXIDE WITH ALIZARIN DYE

LUNDVALL, VON HALVAR
1905 Institute der Universität Lund.
Anat. Anzeiger, Vol. 27, 1905, pages 520-523.
Weiteres über Demonstration embryonaler Skelette.
Material; Human Embryos.
Schultze's method plus alizarin.

DAWSON, ALDEN B.
1926 New York University.
Stain Technology, Vol. 1, No. 4, October, 1926.
A Note on the Staining of the Skeleton of Cleared Specimens with Alizarin Red S.
Material; Rats.
Mall's modification of Schultze's method plus alizarin.

BEEBE, WILLIAM
1929 New York Zoological Society.
Bulletin New York Zoological Society.
March—April, 1929. Vol. XXXII, No. 2.
The Architectural Beauty of Fish.
New Adaptations of an Old Method.
Material; Fish.

HOLLISTER, GLORIA
1930 New York Zoological Society.
Bulletin New York Zoological Society.
March—April, 1930. Vol. XXXIII, No. 2.
Fish Magic.
Material; Fish.
1932 Bulletin New York Zoological Society.
March—April, 1932, Vol. XXXV, No. 2.
A New Use of Ultra-violet Radiation.
Material; Fish.

New York Zoological Society

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THE ZOOLOGICAL PARK, NEW YORK

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ZOOLOGICA

SCIENTIFIC CONTRIBUTIONS OF THE NEW YORK ZOOLOGICAL SOCIETY

VOLUME XIII. NUMBERS 1 AND 2

BERMUDA OCEANOGRAPHIC EXPEDITIONS

1929—1930

No. 1—INTRODUCTION
No. 2—LIST OF NETS AND DATA

By WILLIAM BEEBE

PUBLISHED BY THE SOCIETY
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BERMUDA OCEANOGRAPHIC EXPEDITIONS

1929—1930

INTRODUCTION*

By William Beebe

(Figs. 1-7 incl.)

I. Foreword

The idea of carrying on daily deep-sea trawling with a shore laboratory for a base occurred to me on July 15th, 1925, when I was establishing Station No. 100 on the *Arcturus,* a few miles south of Bermuda. I had not the slightest idea that four years later I should be located on the island of Nonsuch, then visible from the bridge, and with the same winch then in use, I would be trawling over this identical area.

*Contribution, New York Zoological Society, Department of Tropical Research, No. 353.

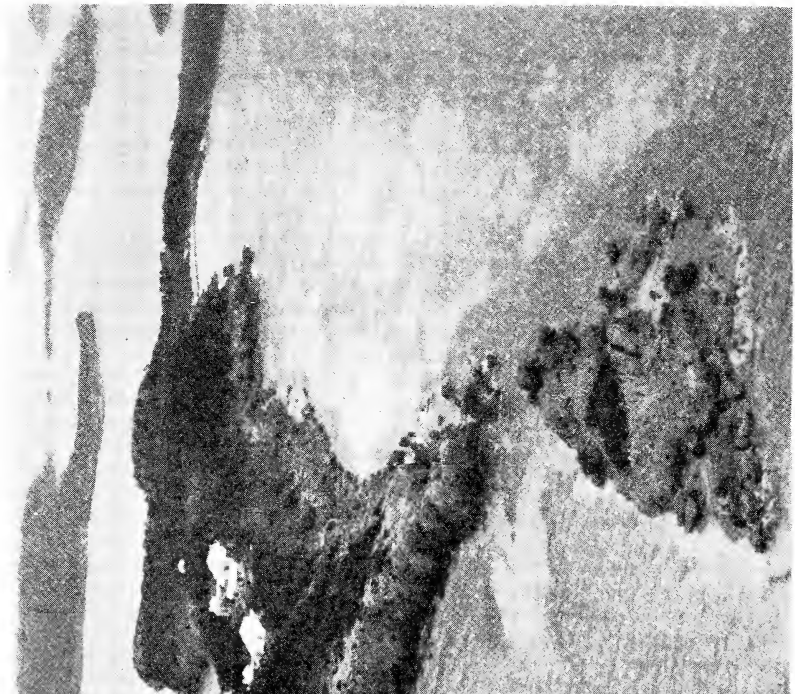

Fig. 1. Airplane view of Nonsuch Island, showing laboratories and neighboring reefs.
Photo by Capt. Nelmes.

The vibrations and other drawbacks to microscopic and similar laboratory work and the very great cost of an expedition like that of the *Arcturus* induced me to begin experiments. I found by several trips to the Hudson Gorge off New York City, that on an ordinary tug boat I could easily haul six one-metre nets at an extreme depth of 1400 fathoms, and that the resulting catches were as varied and rich, and came up in as good condition as those on the *Arcturus*[1]. Two short visits to Bermuda made me certain that this would form an excellent headquarters. Good fortune attended me, for on a picnic to Nonsuch with His Excellency, the late Governor Sir Louis Bols and the Honorable F. Goodwin Gosling, I was offered the use of the island with its excellent buildings if I cared to use it. Examination of the map showed that this was the most desirable place in Bermuda for my work. It was well isolated from the hotels and troublesome tourists, yet within easy reach of St. Georges; Castle Roads was a convenient passage for a vessel to the open sea, and a depth of 1000 fathoms was to be found only five miles off shore to the south.

I found that at St. Georges a sea-going tug, the *Gladisfen,* was available for charter at a reasonable price, and most important of all, when I had assembled all my plans and formulated them, two very great friends, Harrison Williams and Mortimer Schiff, offered to finance the expedition.

This was the evolution of the Bermuda Oceanographic Expedition of the New York Zoological Society.

II. Oceanographic Investigation near Bermuda

The waters of Bermuda have been visited by the vessels of some of the most important oceanographic expeditions. When I am ready to publish the total catch of deep-sea fish taken in the restricted area, I will summarize the hauls and other results of the other expeditions. Here I need only briefly to list the stations:

The *Challenger* in 1873 made twenty-seven Stations and Substations within one hundred miles of my trawling center.
The *Margrethe* in 1913 made three Stations.
The *Dana* in 1920 and 1922 made three Stations.
The *Arcturus* in 1925 made seven Stations.
The *Pawnee* in 1927 made two Stations.
The *Chance* in 1927 made two Stations.
The *Albatross* in 1929 made four Stations.

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[1] Zoologica Vol. XII, Nos. 1; Zool. Soc. Bull. Vol. XXII, No. 2.

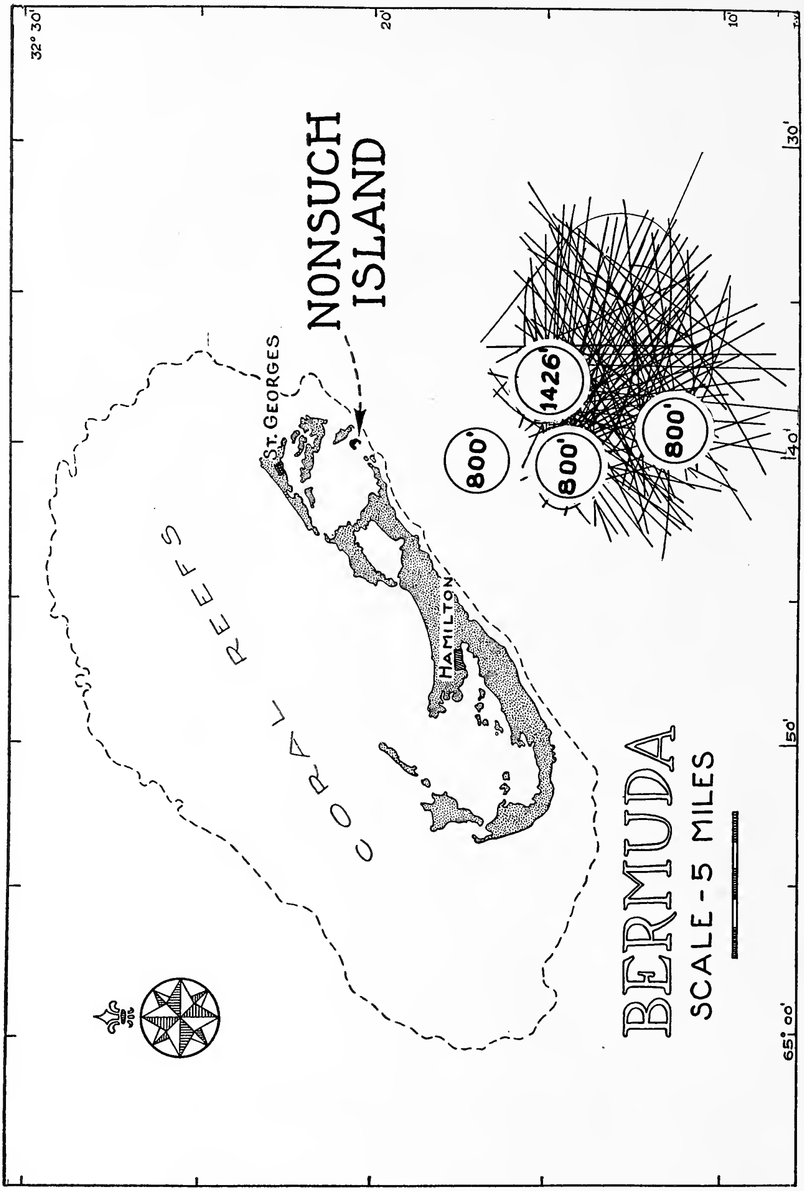

Fig. 2. Diagrammatic view showing Nonsuch Island, the area of trawling, and the location of four deep dives of the Bathysphere.

Tarleton Bean in 1906 in a list of fishes of Bermuda enumerates several deep-sea fish, apparently washed ashore.

III. Collecting Apparatus on the *Gladisfen*

The *Gladisfen* is a sturdy tug ninety-three feet over all. It was found possible to fit her with satisfactory trawling, dredging and sounding apparatus without altering any of her structure. On the forward deck, amidships, just forward of the pilot house was installed the sounding machine, the wire leading to a pivoting yard arm which swung overboard at right angles to the tug when in action.

Immediately aft of the towing bitts was placed the smaller winch or towing engine with its load of 15,000 feet of quarter inch wire. This cable led directly astern over a sheave mounted on steel davits, projecting so far overboard that the descending wire hung clear of the rudder. This gave room for a suspended metre-wheel, for a two-man, block-and-tackle reeling arrangement, and a man to stand and oil the in-coming cable. Instead of freeing the wire of superfluous water by banging it with clubs as we did on the *Arcturus,* two men who attended to the attachment and unfastening of the weight and nets, let the wire run through a mass of sacking with which they gripped the cable.

Both the sounding machine and the towing engine are described by Mr. Tee-Van in the account of the operation and equipment of the *Arcturus.* (Zoologica Vol. VIII, No. 2.)

IV. Trawling Accidents

While it is the custom to record only the successes of an expedition, it has seemed only fair to tell very briefly of the accidents. During the two seasons of work and the hauling of 976 nets we lost nineteen nets by accident, as follows:

3—Lost overboard and in propellor.
3—Ripped from too long use.
7—Torn away when bottom was touched.
1—Torn away from excess speed.
5—Lost from breaking of sister hooks.

Besides this we touched bottom accidently four times without doing any harm to the nets; six nets became entangled or wound about the cable or brass attaching balls, resulting in no catch, and finally two brass balls were lost from the breaking of their hinges without the loss of the nets.

On July 16, 1929, the side of the drum of the towing engine gave way. About a third of the circumference went, the central

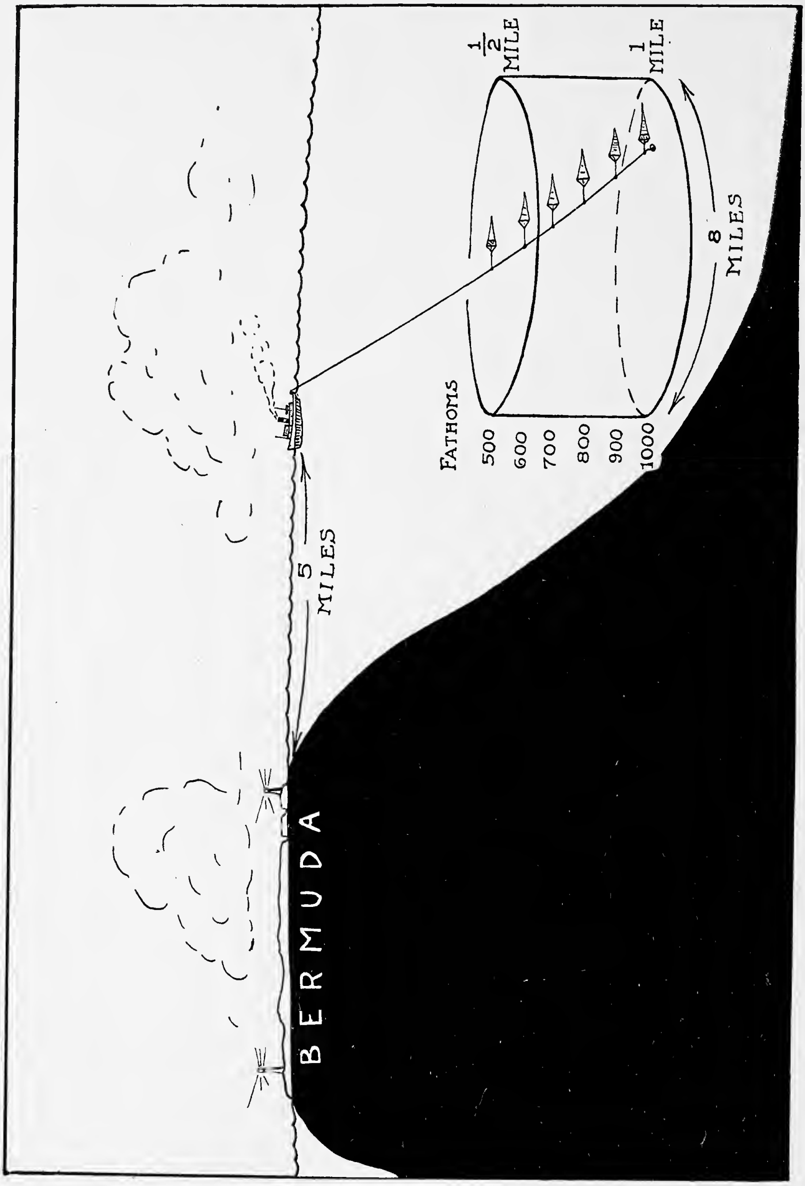

Fig. 3. Diagrammatic section showing the tug and general position of the cylindrical trawling area.

portion down to the core. There was no sign of a break before it actually shattered, and no sound when it collapsed, the piece of metal merely dropping off. Fortunately the collapsed rows of cable did not prevent the operation of the winch, so the wire and nets were saved. The break was repaired in the Government Navy Yard.

Exactly one year later, on July 16, 1930, the reinforced side of the drum again broke, this time so badly that a new drum had to be ordered and installed.

V. Method of Work

Our routine of deep sea work varies little from day to day. The *Gladisfen* with her native Bermudian crew of five, steams out from St. Georges, skirts the west shore of Castle Harbor and ties up at her buoy near our wharf about 7 A. M. Usually before her warning whistle blows the two or three members of my staff due for sea duty that day are on their way with racks of mason jars, lunch, extra nets, pails, shark hooks and bait. They go out in our fast launch the *Skink* and immediately the tug steams out through Castle Roads to the open sea. The succeeding course depends on the wind and currents, but it is usually south or south-west.

When at the rim of my imaginary cylinder, as indicated by the relative position of Gibbs Hill and St. David's Lighthouses, the tug is slowed down and the weight is put overboard. One after another, six one-meter nets are attached at equal distances apart, and then sufficient cable paid out to lower the first net to 1000 fathoms, bringing the upper to 500 fathoms.

Then begins a four or five hour vigil, watch being kept on engine revolutions, winch, wire, angle of the wire both lateral and vertical, as well as for any sign of change in the weather affecting wind, current or wave. The surface is scanned for sharks, dolphins, squids, or other creatures, the air watched for birds, and passing sargassum weed is netted and examined for fish and rare invertebrates.

Occasionally in a flat calm, when weed is abundant, a boat with outboard motor is launched and I have had great sport catching young flying-fish on the wing with a butterfly net.

After as long as possible a haul, the trawling crew is assembled, steam is gotten up, and slowly the cable is reeled in. Two men take their place at the very stern watching the wire and wiping off excess water, another oils the cable as it goes on the reel, two more handle a horizontal block and tackle, guiding the cable back and forth so that it is spooled evenly.

Fig. 4. Tug *Gladisfen* used in all trawling work of the Bermuda Oceanographic Expedition.

Fig. 5. Metre net, sheave, wire and winch on the aft deck of the *Gladisfen*.

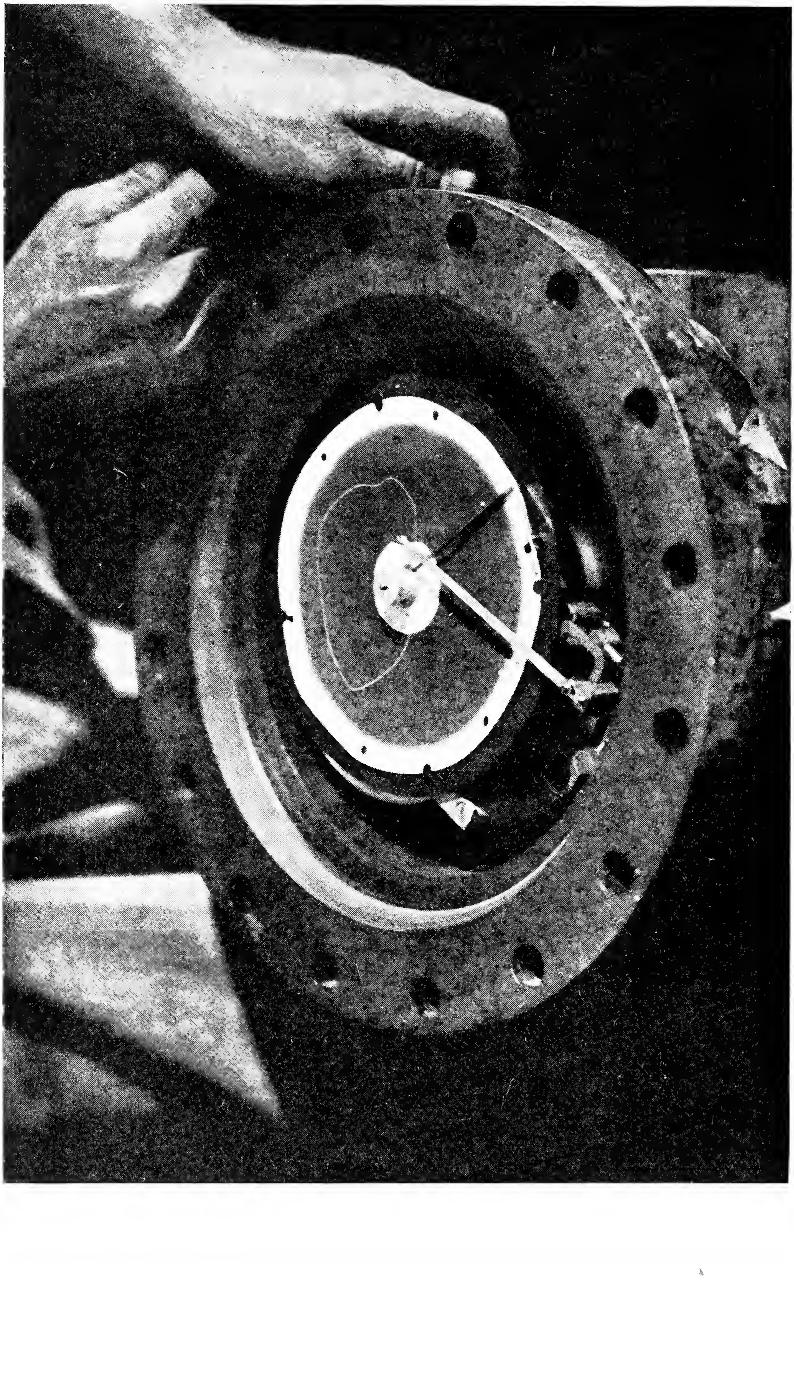

Fig. 6. Clock-work mechanism and recording sheet of the Bathygraph, used for indicating the entire course of a net in trawling.

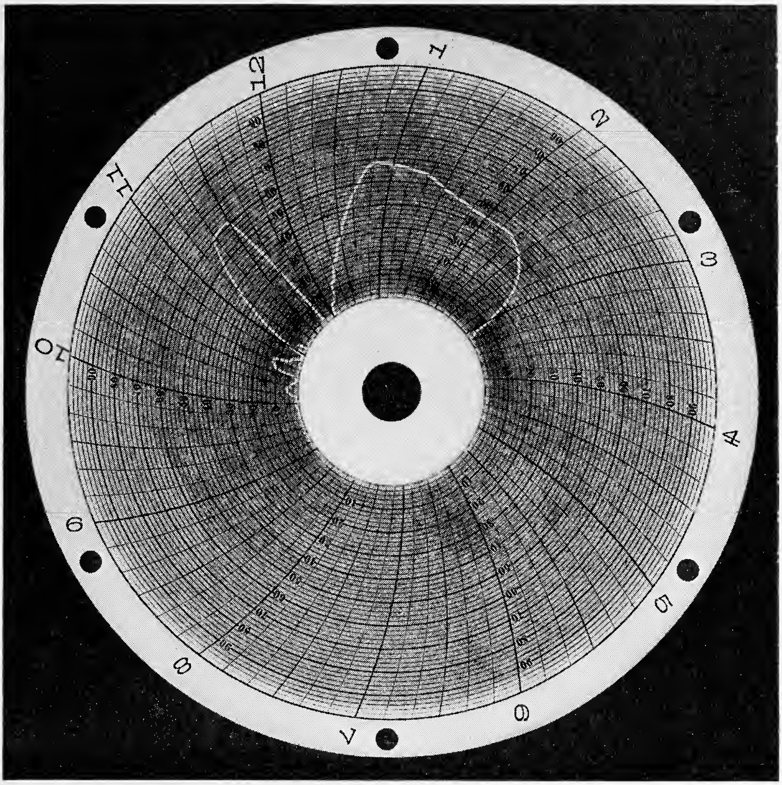

Fig. 7. Record of the Bathygraph showing successively deeper temperature and water sample records, and the course of a thousand fathom trawl continued for two hours.

When the first net appears it is carefully detached, carried into the aft cabin and the mason jar cut free, labelled and placed in its rack. The lower part of the net is then washed for whatever organisms may be caught in it. The entire net is washed and passed to the upper deck to dry. A rough assorting takes place. All large living fish are placed by themselves in a pail with ice. Very delicate forms are placed in formaline. After the last net is aboard the tug is headed full speed for Nonsuch.

At the wharf the jars are carried gently by hand to the laboratory and emptied into individual pans. A finer, thorough assorting now takes place. I pass all new forms showing bright colors to the artist who makes quick color notes; others are taken by the photographer. The great majority are sorted out,

catalogued by those in charge of the vertebrates and the invertebrates, and notes of evanescent color, form and movement made before preservation. The rare living fish and squids are put into the refrigerators, for further study in the morning.

VI. Brief Narrative of the Expedition

An account of the expedition will be given in a future number of Zoologica in full detail. Here it is only necessary to present the more salient facts.

The Expeditions of 1929 and 1930 are known as the 12th and 13th Expeditions of the Department of Tropical Research of the New York Zoological Society, under the Directorship of Dr. William Beebe. The First was in the field from March 13th to October 22nd, 1929, and the Second from April 11th to October 30th, 1930.

The personnel for the two years was as follows:

Director—William Beebe
General Assistant—John Tee-Van
Technical Associate—Gloria Hollister

Scientific Associates

William K. Gregory
Charles J. Fish
Marie P. Fish
E. Newton Harvey
Otis Barton
William Merriam

Laboratory Assistants

P. Boyden
Jocelyn Crane
Margaret Elliott
Alice Wright
Virginia Ziegler

Artists

E. M. Bostelmann
G. Bostelmann
Helen Tee-Van
Llewellyn Miller

Photographers

J. Connery
R. Whitelaw

Field Assistants

Arthur Tucker, Government Care-taker of Nonsuch.
H. Barnes
P. Bass
J. Cannon
P. Crouch
J. Guernsey
A. Hollis
P. Jackson
S. von Hallberg

The chief object of the expedition may be said to be the study of the fish of Bermuda in the widest sense,— those of the tide-pools and shallow waters, of the surface of the ocean, of the mid-waters, and of the abyssmal depths.

In actual practice this divided itself into two divisions—the fish fauna of the shallow waters and those of the ocean deeps. The first we caught and studied by means of hooks and lines, nets, seines, traps, poisons, dynamite, water glasses, glass-bottomed boats, diving helmets and, in the case of adult flying fish, even shot-guns. The fish of the second division were taken with nets, trawls and dredges, and were observed through the quartz windows of the bathysphere down to a depth of a quarter of a mile.

The two most important accessory aids used for the first time on the expeditions were a depth recording gauge of great accuracy which gave complete records of nets down to one thousand fathoms, and the all-steel bathysphere in which Mr. Barton and I were able to descend easily, observe clearly and ascend safely from depths down to 1426 feet. A detailed account of this will be found in the Zoological Society's Bulletin, Volume XXXIII, Number 6, and will be dealt with again in future Zoologicas.

The total cost of each expedition was $33,000 and of this $66,000 Mr. Harrison Williams and Mr. Mortimer Schiff contributed all but $10,000. This latter sum was divided between Burt Massee, F. C. Walcott, Ernest F. Weir, Edna Albert, W. E. Boeing, Herbert L. Satterlee and William Delano.

VII. Locality Chosen for Study

The following 976 nets were hauled through a definite area of open ocean, south of Bermuda. This area is roughly circular, eight miles in diameter, and the great majority of the nets were drawn at 500, 600, 700, 800, 900, and 1000 fathoms.

Observations by means of the two light-houses, Gibbs Hill and St. Davids, made it possible to get accurate sights at the beginning and the end of each individual haul. Soundings give a clear idea of the contour of the bottom of this oceanic cylinder. These, together with physical results of temperature, salinity, oxygen content, etc., will be tabulated at the end of the third year of study.

To give the location with more exactness;—the eight mile circle under consideration has its center at 32° 12′ North Latitude, and 64° 36′ West Longitude, which point is 160 degrees by

the compass, or South-south-east of Nonsuch. Its horizontal boundaries are as follows;—

Northern rim—32° 16′ North Latitude.
Southern rim—32° 8′ North Latitude.
Eastern rim—64° 31′ 20″ West Longitude.
Western rim—64° 40′ 40″ West Longitude.

At no place is its bottom less than 1000 fathoms in depth. It slopes rather rapidly in the northeastern corner to 1357 fathoms, and along its southern border is between 1400 and 1500 fathoms deep. My first deep dive of 803 feet was in the southwest sector, and the 1426 foot dive was on the northern rim.

Zoologica Vol. XIII, No. 2

BERMUDA OCEANOGRAPHIC EXPEDITIONS

1929—1930

INDIVIDUAL NETS AND DATA*

By William Beebe

*Contribution, New York Zoological Society, Department of Tropical Research, No. 354.

VIII. Individual Nets and Data

Nets by vertical distribution—1929

	April	*May*	*June*	*July*	*August*	*Sept.*	*Oct.*	*Total*
Surface	7	5	4	1	1	16	..	34
100	..	2	..	..	..	2	..	4
200	1	3	..	..	..	2	..	6
300	1	4	..	..	..	2	..	7
400	3	6	..	..	4	2	..	15
500	11	9	15	20	6	14	..	75
600	13	15	15	15	6	13	..	77
700	6	13	16	17	6	18	..	76
800	5	11	15	19	7	18	..	75
900	6	15	16	16	6	19	..	78
1000	3	5	15	20	15	20	..	78
1100	..	1	1	..	1	..	..	3
TOTAL	56	89	97	108	52	126	..	528

Nets by vertical distribution—1930

Surface	7	21	12	5	1	4	2	52
100	..	1	1	..	..	3	1	6
200	..	2	1	..	..	3	..	6
300	..	8	1	1	..	6	..	16
400	..	10	4	1	..	10	..	25
500	..	23	4	9	..	21	..	57
600	..	22	2	5	6	22	..	57
700	..	9	16	9	1	21	..	56
800	..	9	17	9	2	20	..	57
900	..	7	19	8	2	21	..	57
1000	..	5	20	11	..	21	..	57
1100	..	1	..	..	..	..	..	1
1200	..	1	..	..	..	..	..	1
TOTAL	7	119	97	58	12	152	3	448

Surface	86
100	10
200	12
300	23
400	40
500	132
600	134
700	132
800	132
900	135
1000	135
1100	4
1200	1
	976

INDIVIDUAL NETS AND DATA

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Apr.		H	M					
1	Metre	400	732	3	10:56AM	1	45	SE	Cloudy	N	5	Rough
2	Metre	500	914	3	10:56	1	45	SE	Cloudy	N	5	Rough
3	Metre	600	1097	3	10:56	1	45	SE	Cloudy	N	5	Rough
4	Metre	400	732	5	1:15PM	1	30	SE	Clear	SW	2	Swell
5	Metre	500	914	5	1:15	1	30	SE	Clear	SW	2	Swell
6	Metre	600	1097	5	1:15	1	30	SE	Clear	SW	2	Swell
7	½Metre	0	0	9	10:36AM	1	54	SSE	Clear	NW	4	Choppy
8	Metre	200	366	9	10:36	1	54	SSE	Clear	NW	4	Choppy
9	Metre	300	549	9	10:36	1	54	SSE	Clear	NW	4	Choppy
10	Metre	400	732	9	10:36	1	54	SSE	Clear	NW	4	Choppy
11	Metre	500	914	9	10:36	1	54	SSE	Clear	NW	4	Choppy
12	Metre	500	914	9	10:36	1	54	SSE	Clear	NW	4	Choppy
13	Metre	600	1097	9	10:36	1	54	SSE	Clear	NW	4	Choppy
14	½Metre	0	0	12	9:25	4	05	S to E	Clear	S	3	Swell
15	Metre	500	914	12	9:25	4	05	S to E	Clear	S	3	Swell
16	Metre	600	1097	12	9:25	4	05	S to E	Clear	S	3	Swell
17	Metre	600	1097	12	9:25	4	05	S to E	Clear	S	3	Swell
18	Metre	700	1280	12	9:25	4	05	S to E	Clear	S	3	Swell
19	½Metre	0	0	14	7:25PM		30	N and S	Cloudy moonlight	SE	0	Calm
20	½Metre	0	0	15	9:13AM	4	17	E to N	Overcast	SE	3	Choppy
21	Metre	500	914	15	9:13	4	17	E to N	Overcast	SE	3	Choppy
22	Metre	600	1097	15	9:13	4	17	E to N	Overcast	SE	3	Choppy
23	Metre	600	1097	15	9:13	4	17	E to N	Overcast	SE	3	Choppy
24	Metre	700	1280	15	9:13	4	17	E to N	Overcast	SE	3	Choppy
25	Metre	800	1463	15	9:13	4	17	E to N	Overcast	SE	3	Choppy
26	Metre	900	1646	15	9:13	4	17	E to N	Overcast	SE	3	Choppy
27	Metre	500	914	20	9:45	2	55	S and E	Clear	NW	4	Swell
28	Metre	500	914	20	9:45	2	55	S and E	Clear	NW	4	Swell
29	Metre	500	914	20	9:45	2	55	S and E	Clear	NW	4	Swell
30	Metre	600	1097	20	9:45	2	55	S and E	Clear	NW	4	Swell
31	Metre	500	914	24	9:54	3	36	SSW	Clear	NE	1	Swell
32	Metre	600	1097	24	9:54	3	36	SSW	Clear	NE	1	Swell
33	Metre	600	1097	24	9:54	3	36	SSW	Clear	NE	1	Swell
34	Metre	700	1280	24	9:54	3	36	SSW	Clear	NE	1	Swell
35	Metre	800	1463	24	9:54	3	36	SSW	Clear	NE	1	Swell
36	Metre	900	1646	24	9:54	3	36	SSW	Clear	NE	1	Swell
37	½Metre	0	0	24	9:54	3	36	SSW	Clear	NE	1	Swell
38	½Metre	0	0	25	10:08	4	0	S and W	Clear	ESE	1	Rough
39	Metre	600	1097	25	10:08	4	0	S and W	Clear	ESE	1	Rough
40	Metre	700	1280	25	10:08	4	0	S and W	Clear	ESE	1	Rough
41	Metre	800	1463	25	10:08	4	0	S and W	Clear	ESE	1	Rough
42	Metre	900	1646	25	10:08	4	0	S and W	Clear	ESE	1	Rough
43	Metre	900	1646	25	10:08	4	0	S and W	Clear	ESE	1	Rough
44	Metre	1000	1829	25	10:08	4	0	S and W	Clear	ESE	1	Rough
45	Metre	500	914	29	10:14	4	0	E to NE	Overcast	SW	3	Rough
46	Metre	600	1097	29	10:14	4	0	E to NE	Overcast	SW	3	Rough
47	Metre	600	1097	29	10:14	4	0	E to NE	Overcast	SW	3	Rough
48	Metre	700	1280	29	10:14	4	0	E to NE	Overcast	SW	3	Rough
49	Metre	800	1463	29	10:14	4	0	E to NE	Overcast	SW	3	Rough
50	Metre	900	1646	29	10:14	4	0	E to NE	Overcast	SW	3	Rough

Individual Nets and Data—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres			H	M			Direction	Force	
				Apr.								
51	½Metre	0	0	29	12:00M	2	0	E to NE	Overcast	SW	3	Rough
52	Metre	700	1280	30	9:43AM	4	2	SW	Squally	NE	2	Swell
53	Metre	800	1463	30	9:43	4	2	SW	Squally	NE	2	Swell
54	Metre	900	1646	30	9:43	4	2	SW	Squally	NE	2	Swell
55	Metre	1000	1829	30	9:43	4	2	SW	Squally	NE	2	Swell
56	Metre	1000	1829	30	9:43	4	2	SW	Squally	NE	2	Swell
				May								
57	½Metre	0	0	1	8:55PM		20	N and S	Starlight	SW	2	Choppy
58	Metre	500	914	3	9:57AM	4	4	SE	Overcast	SSW	2	Choppy
59	Metre	500	914	3	9:57	4	4	SE	Overcast	SSW	2	Choppy
60	Metre	500	914	3	9:57	4	4	SE	Overcast	SSW	2	Choppy
61	Metre	600	1097	3	9:57	4	4	SE	Overcast	SSW	2	Choppy
62	Metre	600	1097	3	9:57	4	4	SE	Overcast	SSW	2	Choppy
63	Metre	600	1097	3	9:57	4	4	SE	Overcast	SSW	2	Choppy
64	Metre	600	1097	4	10:20	3	45	SE to NW	Overcast	E	1	Choppy
65	Metre	700	1280	4	10:20	3	45	SE to NW	Overcast	E	1	Choppy
66	Metre	800	1463	4	10:20	3	45	SE to NW	Overcast	E	1	Choppy
67	Metre	900	1646	4	10:20	3	45	SE to NW	Overcast	E	1	Choppy
68	Metre	1000	1820	4	10:20	3	45	SE to NW	Overcast	E	1	Choppy
69	Metre	1000	1820	4	10:20	3	45	SE to NW	Overcast	E	1	Choppy
70	½Metre	0	0	4	11:40	2	10	SE to NW	Overcast	E	1	Choppy
71	Metre	600	1097	6	10:24	3	45	SE circle	Clear	S	1	Swell
72	Metre	600	1097	6	10:24	3	45	SE circle	Clear	S	1	Swell
73	Metre	700	1280	6	10:24	3	45	SE circle	Clear	S	1	Swell
74	Metre	700	1280	6	10:24	3	45	SE circle	Clear	S	1	Swell
75	Metre	700	1280	6	10:24	3	45	SE circle	Clear	S	1	Swell
76	Metre	800	1463	6	10:24	3	45	SE circle	Clear	S	1	Swell
77	½Metre	0	0	6	12:30PM	1	37	SE circle	Clear	S	1	Swell
78	Metre	600	1097	8	7:25AM	6	40	SE	Squally	W	2	Choppy
79	Metre	700	1280	8	7:25	6	40	SE	Squally	W	2	Choppy
80	Metre	800	1463	8	7:25	6	40	SE	Squally	W	2	Choppy
81	Metre	900	1646	8	7:25	6	40	SE	Squally	W	2	Choppy
82	Metre	900	1646	8	7:25	6	40	SE	Squally	W	2	Choppy
83	Metre	1000	1829	8	7:25	6	40	SE	Squally	W	2	Choppy
84	Metre	100	183	10	9:31	4	34	SE to E	Clear	WSW	2	Choppy
85	Metre	200	366	10	9:31	4	34	SE to E	Clear	WSW	2	Choppy
86	Metre	300	549	10	9:31	4	34	SE to E	Clear	WSW	2	Choppy
87	Metre	400	732	10	9:31	4	34	SE to E	Clear	WSW	2	Choppy
88	Metre	500	914	10	9:31	4	34	SE to E	Clear	WSW	2	Choppy
89	Metre	600	1097	10	9:31	4	34	SE to E	Clear	WSW	2	Choppy
90	Metre	200	366	11	9:35AM	4	30	W to SW	Squally	NE	4	Rough
91	Metre	300	549	11	9:35	4	30	W to SW	Squally	NE	4	Rough
92	Metre	400	732	11	9:35	4	30	W to SW	Squally	NE	4	Rough
93	Metre	500	914	11	9:35	4	30	W to SW	Squally	NE	4	Rough
94	Metre	600	1097	11	9:35	4	30	W to SW	Squally	NE	4	Rough
95	Metre	700	1280	11	9:35	4	30	W to SW	Squally	NE	4	Rough
96	½Metre	0	0	11	12:00	2	0	W to SW	Squally	NE	4	Rough
97	Metre	300	549	14	10:35	3	0	SE to W	Clear	ENE	1	Swell
98	Metre	400	732	14	10:35	3	0	SE to W	Clear	ENE	1	Swell
99	Metre	500	914	14	10:35	3	0	SE to W	Clear	ENE	1	Swell
100	Metre	600	1097	14	10:35	3	0	SE to W	Clear	ENE	1	Swell

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres			H	M			Direction	Force	
				May								
101	Metre	700	1280	14	10:35AM	3	0	SE to W	Clear	ENE	1	Swell
102	Metre	800	1463	14	10:35	3	0	SE to W	Clear	ENE	1	Swell
103	Metre	600	1097	15	9:47	4	16	NE to E	Clear	S	2	Swell
104	Metre	700	1280	15	9:47	4	16	NE to E	Clear	S	2	Swell
105	Metre	800	1453	15	9:47	4	16	NE to E	Clear	S	2	Swell
106	Metre	900	1646	15	9:47	4	16	NE to E	Clear	S	2	Swell
107	Metre	1000	1829	15	9:47	4	16	NE to E	Clear	S	2	Swell
108	Metre	1100	2012	15	9:47	4	16	NE to E	Clear	S	2	Swell
109	Metre	600	1097	16	9:31	4	34	S to SE	Clear	W	1	Calm
110	Metre	700	1280	16	9:31	4	34	S to SE	Clear	W	1	Calm
111	Metre	700	1280	16	9:31	4	34	S to SE	Clear	W	1	Calm
112	Metre	800	1463	16	9:31	4	34	S to SE	Clear	W	1	Calm
113	Metre	800	1463	16	9:31	4	34	S to SE	Clear	W	1	Calm
114	Metre	900	1646	16	9:31	4	34	S to SE	Clear	W	1	Calm
115	Metre	400	732	18	9:39	4	1	S to E	Clear	SW	1	Calm
116	Metre	900	1646	18	9:39	4	1	S to E	Clear	SW	1	Calm
117	Metre	900	1646	18	9:39	4	1	S to E	Clear	SW	1	Calm
118	Metre	900	1646	18	9:39	4	1	S to E	Clear	SW	1	Calm
119	Metre	900	1646	18	9:39	4	1	S to E	Clear	SW	1	Calm
120	Metre	900	1646	18	9:39	4	1	S to E	Clear	SW	1	Calm
121	Metre	600	1097	25	9:45	2	45	SSE	Squally	SW	2	Choppy
122	Metre	700	1280	25	9:45	2	45	SSE	Squally	SW	2	Choppy
123	Metre	800	1463	25	9:45	2	45	SSE	Squally	SW	2	Choppy
124	2Metre	900	1646	25	9:45	2	45	SSE	Squally	SW	2	Choppy
125	Metre	900	1646	25	9:45	2	45	SSE	Squally	SW	2	Choppy
126	Metre	100	183	27	9:30	4	40	ESE to W	Clear	NE	2	Swell
127	Metre	200	366	27	9:30	4	40	ESE to W	Clear	NE	2	Swell
128	Metre	300	549	27	9:30	4	40	ESE to W	Clear	NE	2	Swell
129	Metre	400	732	27	9:30	4	40	ESE to W	Clear	NE	2	Swell
130	Metre	500	914	27	9:30	4	40	ESE to W	Clear	NE	2	Swell
131	Metre	800	1463	27	9:30	4	40	ESE to W	Clear	NE	2	Swell
132	Metre	400	732	28	9:20	3	15	SSE	Cloudy	SE	2	Rough
133	Metre	500	914	28	9:20	3	15	SSE	Cloudy	SE	2	Rough
134	½Metre	0	0	28	8:40PM		20	N and S	Starlight	SE	2	Choppy
135	Metre	600	1097	30	9:55AM	4	5	SSW	Overcast	E	2	Choppy
136	Metre	700	1280	30	9:55	4	5	SSW	Overcast	E	2	Choppy
137	Metre	800	1463	30	9:55	4	5	SSW	Overcast	E	2	Choppy
138	Metre	900	1646	30	9:55	4	5	SSW	Overcast	E	2	Choppy
139	1 Dia.	900	1646	30	9:55	4	5	SSW	Overcast	E	2	Choppy
140	Metre	500	914	31	10:00	4	0	S	Squally	S	3	Choppy
141	Metre	600	1097	31	10:00	4	0	S	Squally	S	3	Choppy
142	Metre	700	1280	31	10:00	4	0	S	Squally	S	3	Choppy
143	Metre	800	1463	31	10:00	4	0	S	Squally	S	3	Choppy
144	Metre	900	1646	31	10:00	4	0	S	Squally	S	3	Choppy
145	Metre	1000	1829	31	10:00	4	0	S	Squally	S	3	Choppy
				June								
146	Metre	500	914	1	9:20	4	0	S	Clear	W	2	Swell
147	Metre	600	1097	1	9:20	4	0	S	Clear	W	2	Swell
148	Metre	700	1280	1	9:20	4	0	S	Clear	W	2	Swell
149	Metre	800	1463	1	9:20	4	0	S	Clear	W	2	Swell
150	Metre	900	1646	1	9:20	4	0	S	Clear	W	2	Swell

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				June		H	M					
151	Metre	1000	1829	1	9:20AM	4	0	S	Clear	W	2	Swell
152	½Metre	0	0	8	10:20	3	45	SxW	Clear	SE	2	Swell
153	Metre	700	1280	8	10:20	3	45	SxW	Clear	SE	2	Swell
154	Metre	800	1463	8	10:20	3	45	SxW	Clear	SE	2	Swell
155	Metre	900	1646	8	10:20	3	45	SxW	Clear	SE	2	Swell
156	Metre	1000	1829	8	10:20	3	45	SxW	Clear	SE	2	Swell
157	2Metre	1100	2012	8	10:20	3	45	SxW	Clear	SE	2	Swell
158	Metre	500	914	12	9:26	4	05	SE	Clear	SW	2	Choppy
159	Metre	600	1097	12	9:26	4	05	SE	Clear	SW	2	Choppy
160	Metre	700	1280	12	9:26	4	05	SE	Clear	SW	2	Choppy
161	Metre	800	1463	12	9:26	4	05	SE	Clear	SW	2	Choppy
162	Metre	900	1646	12	9:26	4	05	SE	Clear	SW	2	Choppy
163	Metre	1000	1829	12	9:26	4	05	SE	Clear	SW	2	Choppy
164	Metre	500	914	14	9:45	4	05	SE	Clear	S	1	Swell
165	Metre	600	1097	14	9:45	4	05	SE	Clear	S	1	Swell
166	Metre	700	1280	14	9:45	4	05	SE	Clear	S	1	Swell
167	Metre	800	1463	14	9:45	4	05	SE	Clear	S	1	Swell
168	Metre	900	1646	14	9:45	4	05	SE	Clear	S	1	Swell
169	2Metre	1000	1829	14	9:45	4	05	SE	Clear	S	1	Swell
170	Metre	500	914	15	9:46	4	02	SW	Clear	ESE	1	Swell
171	Metre	600	1097	15	9:46	4	02	SW	Clear	ESE	1	Swell
172	Metre	700	1280	15	9:46	4	02	SW	Clear	ESE	1	Swell
173	Metre	800	1463	15	9:46	4	02	SW	Clear	ESE	1	Swell
174	Metre	900	1646	15	9:46	4	02	SW	Clear	ESE	1	Swell
175	Metre	1000	1829	15	9:46	4	02	SW	Clear	ESE	1	Swell
176	Metre	500	914	17	9:28	4	02	SW	Clear	WxN	2	Swell
177	Metre	600	1097	17	9:28	4	02	SW	Clear	WxN	2	Swell
178	Metre	700	1280	17	9:28	4	02	SW	Clear	WxN	2	Swell
179	Metre	800	1463	17	9:28	4	02	SW	Clear	WxN	2	Swell
180	Metre	900	1646	17	9:28	4	02	SW	Clear	WxN	2	Swell
181	2Metre	1000	1829	17	9:28	4	02	SW	Clear	WxN	2	Swell
182	Metre	500	914	18	9:35	4	0	SE	Clear	NW	2	Choppy
183	Metre	600	1097	18	9:35	4	0	SE	Clear	NW	2	Choppy
184	Metre	700	1280	18	9:35	4	0	SE	Clear	NW	2	Choppy
185	Metre	900	1646	18	9:35	4	0	SE	Clear	NW	2	Choppy
186	2Metre	1000	1829	18	9:35	4	0	SE	Clear	NW	2	Choppy
187	Metre	500	914	19	9:50	4	10	SxE	Clear	WxN	2	Moderate
188	Metre	600	1097	19	9:50	4	10	SxE	Clear	WxN	2	Moderate
189	Metre	700	1280	19	9:50	4	10	SxE	Clear	WxN	2	Moderate
190	Metre	800	1463	19	9:50	4	10	SxE	Clear	WxN	2	Moderate
191	Metre	900	1646	19	9:50	4	10	SxE	Clear	WxN	2	Moderate
192	2Metre	1000	1829	19	9:50	4	10	SxE	Clear	WxN	2	Moderate
193	Metre	500	914	20	9:41	4	03	SE to E	Clear	W	3	Rough
194	Metre	600	1097	20	9:41	4	03	SE to E	Clear	W	3	Rough
195	Metre	700	1280	20	9:41	4	03	SE to E	Clear	W	3	Rough
196	Metre	800	1463	20	9:41	4	03	SE to E	Clear	W	3	Rough
197	Metre	900	1646	20	9:41	4	03	SE to E	Clear	W	3	Rough
198	2Metre	1000	1829	20	9:41	4	03	SE to E	Clear	W	3	Rough
199	Metre	500	914	21	9:47	4	03	SxE	Clear	WSW	4	Moderate
200	Metre	600	1097	21	9:47	4	03	SxE	Clear	WSW	4	Moderate
201	Metre	700	1280	21	9:47	4	03	SxE	Clear	WSW	4	Moderate

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres			H	M			Direction	Force	
				June								
202	Metre	800	1463	21	9:47AM	4	03	SxE	Clear	WSW	4	Moderate
203	Metre	900	1646	21	9:47	4	03	SxE	Clear	WSW	4	Moderate
204	Metre	1000	1829	21	9:47	4	03	SxE	Clear	WSW	4	Moderate
205	Metre	500	914	22	9:50	3	0	SxE	Squally	SSE	4	Rough
206	Metre	600	1097	22	9:50	3	0	SxE	Squally	SSE	4	Rough
207	Metre	700	1280	22	9:50	3	0	SxE	Squally	SSE	4	Rough
208	Metre	800	1463	22	9:50	3	0	SxE	Squally	SSE	4	Rough
209	Metre	900	1646	22	9:50	3	0	SxE	Squally	SSE	4	Rough
210	Metre	1000	1829	22	9:50	3	0	SxE	Squally	SSE	4	Rough
211	Metre	500	914	24	10:05	4	05	SxE	Clear	S	3	Moderate
212	Metre	600	1097	24	10:25	4	05	SxE	Clear	S	3	Moderate
213	Metre	700	1280	24	10:25	4	05	SxE	Clear	S	3	Moderate
214	Metre	800	1463	24	10:25	4	05	SxE	Clear	S	3	Moderate
215	Metre	900	1646	24	10:25	4	05	SxE	Clear	S	3	Moderate
216	Metre	1000	1829	24	10:25	4	05	SxE	Clear	S	3	Moderate
217	Metre	500	914	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
218	Metre	600	1097	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
219	Metre	700	1280	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
220	Metre	800	1463	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
221	Metre	900	1646	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
222	Metre	1000	1829	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
223	½Metre	0	0	25	9:39	4	01	SSE to E	Clear	SSW	3	Swell
224	Metre	500	914	27	9:30PM	8	0	E to N	Moonlight	SW	2	Calm
225	Metre	600	1097	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
226	Metre	700	1280	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
227	Metre	800	1463	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
228	Metre	900	1646	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
229	Metre	1000	1829	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
230	½Metre	0	0	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
231	½Metre	0	0	27	9:30	8	0	E to N	Moonlight	SW	2	Calm
232	Metre	500	914	28	9:45AM	4	10	SSE	Squally	WxN	4	Rough
233	Metre	600	1097	28	9:45	4	10	SSE	Squally	WxN	4	Rough
234	Metre	700	1280	28	9:45	4	10	SSE	Squally	WxN	4	Rough
235	Metre	800	1463	28	9:45	4	10	SSE	Squally	WxN	4	Rough
236	Metre	900	1646	28	9:45	4	10	SSE	Squally	WxN	4	Rough
237	Metre	1000	1829	28	9:45	4	10	SSE	Squally	WxN	4	Rough
238	Metre	500	914	29	9:54	3	20	SE	Squally	SW	4	Rough
239	Metre	600	1097	29	9:54	3	20	SE	Squally	SW	4	Rough
240	Metre	700	1280	29	9:54	3	20	SE	Squally	SW	4	Rough
241	Metre	800	1463	29	9:54	3	20	SE	Squally	SW	4	Rough
242	Metre	900	1646	29	9:54	3	20	SE	Squally	SW	4	Rough
				July								
243	Metre	600	1097	1	12:18PM	2	02	ESE	Squally	W	4	Rough
244	Metre	700	1280	1	12:18	2	02	ESE	Squally	W	4	Rough
245	Metre	800	1463	1	12:18	2	02	ESE	Squally	W	4	Rough
246	Metre	900	1646	1	12:18	2	02	ESE	Squally	W	4	Rough
247	Metre	1000	1829	1	12:18	2	02	ESE	Squally	W	4	Rough
248	Metre	500	914	4	9:40AM	4	02	ESE	Overcast	SW	3	Swell
249	Metre	600	1097	4	9:40	4	02	ESE	Overcast	SW	3	Swell
250	Metre	700	1280	4	9:40	4	02	ESE	Overcast	SW	3	Swell
251	Metre	800	1463	4	9:40	4	02	ESE	Overcast	SW	3	Swell

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth Fathoms	Depth Metres	Date 1929	Start. of Haul	Duration of Haul H	Duration of Haul M	Direction of Haul	Weather	Wind Direction	Wind Force	Sea
				July		H	M					
252	Metre	900	1646	4	9:40AM	4	02	ESE	Overcast	SW	3	Swell
253	Metre	1000	1829	4	9:40	4	02	ESE	Overcast	SW	3	Swell
254	Metre	500	914	5	9:32	4	0	SExE	Clear	SSW	2	Calm
255	Metre	600	1097	5	9:32	4	0	SExE	Clear	SSW	2	Calm
256	Metre	700	1280	5	9:32	4	0	SExE	Clear	SSW	2	Calm
257	Metre	800	1463	5	9:32	4	0	SExE	Clear	SSW	2	Calm
258	Metre	900	1646	5	9:32	4	0	SExE	Clear	SSW	2	Calm
259	Metre	1000	1829	5	9:32	4	0	SExE	Clear	SSW	2	Calm
260	Metre	500	914	6	9:45	4	0	SW	Clear	SW	2	Calm
261	Metre	600	1097	6	9:45	4	0	SW	Clear	SW	2	Calm
262	Metre	700	1280	6	9:45	4	0	SW	Clear	SW	2	Calm
263	Metre	800	1463	6	9:45	4	0	SW	Clear	SW	2	Calm
264	Metre	900	1646	6	9:45	4	0	SW	Clear	SW	2	Calm
265	2Metre	1000	1829	6	9:45	4	0	SW	Clear	SW	2	Calm
266	Metre	500	914	8	10:16	4	0	SExS	Clear	SE	1	Swell
267	Metre	600	1097	8	10:16	4	0	SExS	Clear	SE	1	Swell
268	Metre	700	1280	8	10:16	4	0	SExS	Clear	SE	1	Swell
269	Metre	800	1463	8	10:16	4	0	SExS	Clear	SE	1	Swell
270	Metre	900	1646	8	10:16	4	0	SExS	Clear	SE	1	Swell
271	2Metre	1000	1829	8	10:16	4	0	SExS	Clear	SE	1	Swell
272	Metre	500	914	9	9:45	4	0	S to NW	Clear	S	1	Calm
273	Metre	600	1097	9	9:45	4	0	S to NW	Clear	S	1	Calm
274	Metre	700	1280	9	9:45	4	0	S to NW	Clear	S	1	Calm
275	Metre	800	1463	9	9:45	4	0	S to NW	Clear	S	1	Calm
276	Metre	900	1646	9	9:45	4	0	S to NW	Clear	S	1	Calm
277	2Metre	1000	1829	9	9:45	4	0	S to NW	Clear	S	1	Calm
278	Metre	500	914	10	9:42	4	08	SW	Clear	NE	1	Calm
279	Metre	600	1097	10	9:42	4	08	SW	Clear	NE	1	Calm
280	Metre	700	1280	10	9:42	4	08	SW	Clear	NE	1	Calm
281	Metre	800	1463	10	9:42	4	08	SW	Clear	NE	1	Calm
282	Metre	900	1646	10	9:42	4	08	SW	Clear	NE	1	Calm
283	2Metre	1000	1829	10	9:42	4	08	SW	Clear	NE	1	Calm
284	½Metre	0	0	10	10:00	3	00	SW	Clear	NE	1	Calm
285	Metre	500	914	11	9:35	4	0	SE	Clear	ESE	2	Calm
286	Metre	600	1097	11	9:35	4	0	SE	Clear	ESE	2	Calm
287	Metre	700	1280	11	9:35	4	0	SE	Clear	ESE	2	Calm
288	Metre	800	1463	11	9:35	4	0	SE	Clear	ESE	2	Calm
289	Metre	900	1646	11	9:35	4	0	SE	Clear	ESE	2	Calm
290	2Metre	1000	1829	11	9:35	4	0	SE	Clear	ESE	2	Calm
291	Metre	500	914	12	9:33	4	07	SExS	Clear	NE	1	Calm
292	Metre	600	1097	12	9:33	4	07	SExS	Clear	NE	1	Calm
293	Metre	700	1280	12	9:33	4	07	SExS	Clear	NE	1	Calm
294	Metre	800	1463	12	9:33	4	07	SExS	Clear	NE	1	Calm
295	Metre	900	1646	12	9:33	4	07	SExS	Clear	NE	1	Calm
296	2Metre	1000	1829	12	9:33	4	07	SExS	Clear	NE	1	Calm
297	Metre	500	914	13	9:25	4	0	S	Overcast	ENE	1	Moderate
298	Metre	600	1097	13	9:25	4	0	S	Overcast	ENE	1	Moderate
299	Metre	700	1280	13	9:25	4	0	S	Overcast	ENE	1	Moderate
300	Metre	800	1463	13	9:25	4	0	S	Overcast	ENE	1	Moderate
301	Metre	900	1646	13	9:25	4	0	S	Overcast	ENE	1	Moderate
302	2Metre	1000	1829	13	9:25	4	0	S	Overcast	ENE	1	Moderate

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				July		H	M					
303	Metre	500	914	16	10:01AM	3	50	ESE to E	Squally	WSW	1	Rough
304	Metre	500	914	16	10:01	3	50	ESE to E	Squally	WSW	1	Rough
305	Metre	600	1097	16	10:01	3	50	ESE to E	Squally	WSW	1	Rough
306	Metre	700	1280	16	10:01	3	50	ESE to E	Squally	WSW	1	Rough
307	Metre	800	1463	16	10:01	3	50	ESE to E	Squally	WSW	1	Rough
308	2Metre	900	1646	16	10:01	3	50	ESE to E	Squally	WSW	1	Rough
309	Metre	500	914	22	10:00	3	55	S and W	Clear	ESE	2	Calm
310	Metre	600	1097	22	10:00	3	55	S and W	Clear	ESE	2	Calm
311	Metre	600	1097	22	10:00	3	55	S and W	Clear	ESE	2	Calm
312	Metre	700	1280	22	10:00	3	55	S and W	Clear	ESE	2	Calm
313	Metre	800	1463	22	10:00	3	55	S and W	Clear	ESE	2	Calm
314	2Metre	900	1646	22	10:00	3	55	S and W	Clear	ESE	2	Calm
315	Metre	500	914	23	9:42	4	03	SW	Clear	E	0	Swell
316	Metre	600	1097	23	9:42	4	03	SW	Clear	E	0	Swell
317	Metre	700	1280	23	9:42	4	03	SW	Clear	E	0	Swell
318	Metre	800	1463	23	9:42	4	03	SW	Clear	E	0	Swell
319	Metre	900	1646	23	9:42	4	03	SW	Clear	E	0	Swell
320	2Metre	1000	1829	23	9:42	4	03	SW	Clear	E	0	Swell
321	Metre	600	1097	24	10:10	3	0	ExS	Clear	W	2	Calm
322	Metre	700	1280	24	10:10	3	0	ExS	Clear	W	2	Calm
323	Metre	800	1463	24	10:10	3	0	ExS	Clear	W	2	Calm
324	Metre	800	1463	24	10:10	3	0	ExS	Clear	W	2	Calm
325	Metre	900	1646	24	10:10	3	0	SxE	Clear	W	2	Calm
326	2Metre	1000	1829	24	10:10	3	0	SxE	Clear	W	2	Calm
327	Metre	700	1280	27	10:00	3	25	ExS	Squally	W	3	Rough
328	Metre	800	1463	27	10:00	3	25	ExS	Squally	W	3	Rough
329	Metre	800	1463	27	10:00	3	25	ExS	Squally	W	3	Rough
330	Metre	900	1646	27	10:10	3	25	ExS	Squally	W	3	Rough
331	Metre	1000	1829	27	10:10	3	25	ExS	Squally	W	3	Rough
332	Metre	1000	1829	27	10:10	3	25	ExS	Squally	W	3	Rough
333	Metre	500	914	29	11:40	2	0	ExS	Clear	W	2	Choppy
334	Metre	500	914	29	11:40	2	0	ExS	Clear	W	2	Choppy
335	Metre	700	1280	29	11:40	2	0	ExS	Clear	W	2	Choppy
336	Metre	800	1463	29	11:40	2	0	ExS	Clear	W	2	Choppy
337	Metre	1000	1829	29	11:40	2	0	ExS	Clear	W	2	Choppy
338	Metre	1000	1829	29	11:40	2	0	ExS	Clear	W	2	Choppy
339	Metre	500	914	30	9:58	4	02	SE	Squally	W	1	Calm
340	Metre	500	914	30	9:58	4	02	SE	Squally	W	1	Calm
341	Metre	700	1280	30	9:58	4	02	SE	Squally	W	1	Calm
342	Metre	800	1463	30	9:58	4	02	SE	Squally	W	1	Calm
343	Metre	1000	1829	30	9:58	4	02	SE	Squally	W	1	Calm
344	Metre	1000	1829	30	9:58	4	02	SE	Squally	W	1	Calm
345	Metre	500	914	31	10:10	3	0	SE	Clear	SW	3	Choppy
346	Metre	500	914	31	10:10	3	0	SE	Clear	SW	3	Choppy
347	Metre	500	914	31	10:10	3	0	SE	Clear	SW	3	Choppy
348	Metre	900	1646	31	10:10	3	0	SE	Clear	SW	3	Choppy
349	Metre	1000	1829	31	10:10	3	0	SE	Clear	SW	3	Choppy
350	Metre	1000	1829	31	10:10	3	0	SE	Clear	SW	3	Choppy
				Aug.								
351	Metre	1000	1829	8	1:20PM	1	0	SE	Clear	W	3	Calm
352	Metre	1000	1829	8	1:20	1	0	SE	Clear	W	3	Calm

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Aug.		H	M					
353	Metre	1000	1829	8	1:20PM	1	0	SE	Clear	W	3	Calm
354	Metre	500	914	9	9:27	4	03	SE	Clear	W	3	Moderate
355	Metre	600	1097	9	9:27	4	03	SE	Clear	W	3	Moderate
356	Metre	700	1280	9	9:27	4	03	SE	Clear	W	3	Moderate
357	Metre	800	1463	9	9:27	4	03	SE	Clear	W	3	Moderate
358	Metre	900	1646	9	9:27	4	03	SE	Clear	W	3	Moderate
359	Metre	1000	1829	9	9:27	4	03	SE	Clear	W	3	Moderate
360	Metre	400	732	10	9:50	4	0	ESE	Overcast	W	3	Calm
361	Metre	500	914	10	9:50	4	0	ESE	Overcast	W	3	Calm
362	Metre	900	1646	10	9:50	4	0	ESE	Overcast	W	3	Calm
363	Metre	1000	1829	10	9:50	4	0	ESE	Overcast	W	3	Calm
364	Metre	1000	1829	10	9:50	4	0	ESE	Overcast	W	3	Calm
365	Metre	1000	1829	10	9:50	4	0	ESE	Overcast	W	3	Calm
366	Metre	400	732	14	12:08	2	02	S	Overcast	SW	3	Swell
367	Metre	400	732	14	12:08	2	02	S	Overcast	SW	3	Swell
368	Metre	700	1280	14	12:08	2	02	S	Overcast	SW	3	Swell
369	Metre	800	1463	14	12:08	2	02	S	Overcast	SW	3	Swell
370	Metre	1000	1829	14	12:08	2	02	S	Overcast	SW	3	Swell
371	Metre	1000	1829	14	12:08	2	02	S	Overcast	SW	3	Swell
372	Metre	400	732	15	9:40	4	20	SxE	Overcast	SW	3	Swell
373	Metre	500	914	15	9:40	4	20	SxE	Overcast	SW	3	Swell
374	Metre	600	1097	15	9:40	4	20	SxE	Overcast	SW	3	Swell
375	Metre	800	1463	15	9:40	4	20	SxE	Overcast	SW	3	Swell
376	Metre	1000	1829	15	9:40	4	20	SxE	Overcast	SW	3	Swell
377	Metre	1000	1829	15	9:40	4	20	SxE	Overcast	SW	3	Swell
378	Metre	500	914	16	9:27	4	03	SE	Clear	SW	2	Swell
379	Metre	600	1097	16	9:27	4	03	SE	Clear	SW	2	Swell
380	Metre	700	1280	16	9:27	4	03	SE	Clear	SW	2	Swell
381	Metre	800	1463	16	9:27	4	03	SE	Clear	SW	2	Swell
382	Metre	900	1646	16	9:27	4	03	SE	Clear	SW	2	Swell
383	Metre	1000	1829	16	9:27	4	03	SE	Clear	SW	2	Swell
384	Metre	500	914	17	9:30	4	0	SE to E	Overcast	SW	1	Calm
385	Metre	600	1097	17	9:30	4	0	SE to E	Overcast	SW	1	Calm
386	Metre	700	1280	17	9:30	4	0	SE to E	Overcast	SW	1	Calm
387	Metre	800	1463	17	9:30	4	0	SE to E	Overcast	SW	1	Calm
388	Metre	900	1646	17	9:30	4	0	SE to E	Overcast	SW	1	Calm
389	Metre	1000	1829	17	9:30	4	0	SE to E	Overcast	SW	1	Calm
390	Metre	500	914	19	9:40	4	0	ESE	Clear	W	2	Calm
391	Metre	600	1097	19	9:40	4	0	ESE	Clear	W	2	Calm
392	Metre	700	1280	19	9:40	4	0	ESE	Clear	W	2	Calm
393	Metre	800	1463	19	9:40	4	0	ESE	Clear	W	2	Calm
394	Metre	900	1646	19	9:40	4	0	ESE	Clear	W	2	Calm
395	Metre	1000	1829	19	9:40	4	0	ESE	Clear	W	2	Calm
396	Metre	600	1097	31	10:00	4	0	ESE	Clear	SW	2	Rough
397	Metre	700	1280	31	10:00	4	0	ESE	Clear	SW	2	Rough
398	Metre	800	1463	31	10:00	4	0	ESE	Clear	SW	2	Rough
399	Metre	900	1646	31	10:00	4	0	ESE	Clear	SW	2	Rough
400	Metre	1000	1829	31	10:00	4	0	ESE	Clear	SW	2	Rough
401	Metre	1100	2011	31	10:00	4	0	ESE	Clear	SW	2	Rough
402	Metre	2	7	31	10:00	4	0	ESE	Clear	SW	2	Rough

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Sept.		H	M					
403	Metre	500	914	2	9:45AM	4	10	SW	Overcast	NExN	3	Calm
404	Metre	600	1097	2	9:45	4	10	SW	Overcast	NExN	3	Calm
405	Metre	700	1280	2	9:45	4	10	SW	Overcast	NExN	3	Calm
406	Metre	800	1463	2	9:45	4	10	SW	Overcast	NExN	3	Calm
407	Metre	900	1646	2	9:45	4	10	SW	Overcast	NExN	3	Calm
408	Metre	1000	1829	2	9:45	4	10	SW	Overcast	NExN	3	Calm
409	Metre	500	914	3	9:30	4	0	SW	Misty	NNW	4	Rough
410	Metre	600	1097	3	9:30	4	0	SW	Misty	NNW	4	Rough
411	Metre	700	1280	3	9:30	4	0	SW	Misty	NNW	4	Rough
412	Metre	800	1463	3	9:30	4	0	SW	Misty	NNW	4	Rough
413	Metre	900	1646	3	9:30	4	0	SW	Misty	NNW	4	Rough
414	Metre	1000	1829	3	9:30	4	0	SW	Misty	NNW	4	Rough
415	Metre	2	7	3	9:05	4	25	SW	Misty	NNW	4	Rough
416	Metre	500	914	4	9:32	4	03	SW	Misty	N	3	Choppy
417	Metre	600	1097	4	9:32	4	03	SW	Misty	N	3	Choppy
418	Metre	700	1280	4	9:32	4	03	SW	Misty	N	3	Choppy
419	Metre	800	1463	4	9:32	4	03	SW	Misty	N	3	Choppy
420	Metre	900	1646	4	9:32	4	03	SW	Misty	N	3	Choppy
421	Metre	1000	1829	4	9:32	4	03	SW	Misty	N	3	Choppy
422	Metre	2	7	4	8:40	4	50	SW	Misty	N	3	Choppy
423	Metre	500	914	5	9:45	4	0	SW	Clear	E	1	Calm
424	Metre	600	1097	5	9:45	4	0	SW	Clear	E	1	Calm
425	Metre	700	1280	5	9:45	4	0	SW	Clear	E	1	Calm
426	Metre	800	1463	5	9:45	4	0	SW	Clear	E	1	Calm
427	Metre	900	1646	5	9:45	4	0	SW	Clear	E	1	Calm
428	2Metre	1000	1829	5	9:45	4	0	SW	Clear	E	1	Calm
429	Metre	2	7	5	9:20	4	20		Clear	E	1	Calm
430	Metre	500	914	6	9:50	4	0	S	Misty	ESE	1	Calm
431	Metre	600	1097	6	9:50	4	0	S	Misty	ESE	1	Calm
432	Metre	700	1280	6	9:50	4	0	S	Misty	ESE	1	Calm
433	Metre	800	1463	6	9:50	4	0	S	Misty	ESE	1	Calm
434	Metre	900	1646	6	9:50	4	0	S	Misty	ESE	1	Calm
435	2Metre	1000	1829	6	9:50	4	0	S	Misty	ESE	1	Calm
436	Misty	2	7	6	9:25	4	20	S	Misty	ESE	1	Calm
437	Metre	500	914	7	9:50	4	0	SW	Overcast	SE	3	Choppy
438	Metre	600	1097	7	9:50	4	0	SW	Overcast	SE	3	Choppy
439	Metre	700	1280	7	9:50	4	0	SW	Overcast	SE	3	Choppy
440	Metre	900	1646	7	9:50	4	0	SW	Overcast	SE	3	Choppy
441	Metre	1000	1829	7	9:50	4	0	SW	Overcast	SE	3	Choppy
442	2Metre	1000	1829	7	9:50	4	0	SW	Overcast	SE	3	Choppy
443	Metre	2	7	7	8:45	5	05	SW	Overcast	SE	3	Choppy
444	Metre	500	914	9	11:35	2	25	SW	Clear	SE	2	Moderate
445	Metre	600	1097	9	11:35	2	25	SW	Clear	SE	2	Moderate
446	Metre	700	1280	9	11:35	2	25	SW	Clear	SE	2	Moderate
447	Metre	800	1463	9	11:35	2	25	SW	Clear	SE	2	Moderate
448	Metre	900	1646	9	11:35	2	25	SW	Clear	SE	2	Moderate
449	2Metre	1000	1829	9	11:35	2	25	SW	Clear	SE	2	Moderate
450	Metre	2	7	9	11:15	2	45	SW	Clear	SE	2	Moderate
451	Metre	500	914	10	9:35	4	0	SW	Clear	SE	1	Calm
452	Metre	500	914	10	9:35	4	0	SW	Clear	SE	1	Calm
453	Metre	600	1097	10	9:35	4	0	SW	Clear	SE	1	Calm

Individual Nets and Data—*Continued*

Net No.	Type of Net	Depth Fath-oms	Depth Metres	Date 1929	Start of Haul	Duration of Haul H	Duration of Haul M	Direction of Haul	Weather	Wind Direction	Wind Force	Sea
				Sept.		H	M					
454	Metre	900	1646	10	9:35AM	4	0	SW	Clear	SE	1	Calm
455	Metre	1000	1829	10	9:35	4	0	SW	Clear	SE	1	Calm
456	2Metre	1000	1829	10	9:35	4	0	SW	Clear	SE	1	Calm
457	Metre	2	7	10	9:20	4	05	SW	Clear	SE	1	Calm
458	Metre	300	549	11	9:30	4	0	SW	Clear	SE	1	Calm
459	Metre	400	732	11	9:30	4	0	SW	Clear	SE	1	Calm
460	Metre	700	1280	11	9:30	4	0	SW	Clear	SE	1	Calm
461	Metre	800	1463	11	9:30	4	0	SW	Clear	SE	1	Calm
462	Metre	900	1646	11	9:30	4	0	SW	Clear	SE	1	Calm
463	Metre	1000	1829	11	9:30	4	0	SW	Clear	SE	1	Calm
464	Metre	2	7	11	9:20	4	10	SW	Clear	SE	1	Calm
465	Metre	800	1463	12	9:00	4	0	SW	Clear	SE	1	Calm
466	Metre	900	1646	12	9:00	4	0	SW	Clear	SE	1	Calm
467	Metre	900	1646	12	9:00	4	0	SW	Clear	SE	1	Calm
468	Metre	1000	1829	12	9:00	4	0	SW	Clear	SE	1	Calm
469	Metre	1000	1829	12	9:00	4	0	SW	Clear	SE	1	Calm
470	2Metre	1000	1829	12	9:00	4	0	SW	Clear	SE	1	Calm
471	Metre	2	7	12	8:22	4	38		Clear	SE	1	Calm
472	Metre	100	183	13	9:30	4	0	SW	Clear	SE	3	Choppy
473	Metre	200	366	13	9:30	4	0	SW	Clear	SE	3	Choppy
474	Metre	700	1280	13	9:30	4	0	SW	Clear	SE	3	Choppy
475	Metre	800	1463	13	9:30	4	0	SW	Clear	SE	3	Choppy
476	Metre	900	1646	13	9:30	4	0	SW	Clear	SE	3	Choppy
477	Metre	2	7	13	9:30	4	0	SW	Clear	SE	3	Choppy
478	Metre	500	914	20	9:40	4	0	SxW	Overcast	S	1	Swell
479	Metre	600	1097	20	9:40	4	0	SxW	Overcast	S	1	Swell
480	Metre	700	1280	20	9:40	4	0	SxW	Overcast	S	1	Swell
481	Metre	800	1463	20	9:40	4	0	SxW	Overcast	S	1	Swell
482	Metre	900	1646	20	9:40	4	0	SxW	Overcast	S	1	Swell
483	Metre	1000	1829	20	9:40	4	0	SxW	Overcast	S	1	Swell
484	Metre	500	914	21	9:44	4	0	S	Clear	SW	3	Moderate
485	Metre	600	1097	21	9:44	4	0	S	Clear	SW	3	Moderate
486	Metre	700	1280	21	9:44	4	0	S	Clear	SW	3	Moderate
487	Metre	800	1463	21	9:44	4	0	S	Clear	SW	3	Moderate
488	Metre	900	1646	21	9:44	4	0	S	Clear	SW	3	Moderate
489	Metre	1000	1829	21	9:44	4	0	S	Clear	SW	3	Moderate
490	Metre	2	7	21	9:44	4	0	S	Clear	SW	3	Moderate
491	½Metre	2	7	22	2:00PM		35	S and N	Clear	SW	1	Calm
492	Metre	500	914	23	10:05AM	2	0	S to SW	Clear	SE	1	Swell
493	Metre	600	1097	23	10:05	2	0	S to SW	Clear	SE	1	Swell
494	Metre	700	1280	23	10:05	2	0	S to SW	Clear	SE	1	Swell
495	Metre	800	1463	23	10:05	2	0	S to SW	Clear	SE	1	Swell
496	Metre	900	1646	23	10:05	2	0	S to SW	Clear	SE	1	Swell
497	Metre	1000	1829	23	10:05	2	0	S to SW	Clear	SE	1	Swell
498	Metre	2	7	23	10:05	2	0	S to SW	Clear	SE	1	Swell
499	Metre	800	1463	24	10:35	3	0	E	Squally	W	3	Rough
500	Metre	900	1646	24	10:35	3	0	E	Squally	W	3	Rough
501	Metre	900	1646	24	10:35	3	0	E	Squally	W	3	Rough
502	Metre	900	1646	24	10:35	3	0	E	Squally	W	3	Rough
503	Metre	2	7	24	10:35	3	0	E	Squally	W	3	Rough
504	Metre	500	914	25	10:10	3	20	SE	Overcast	SW	3	Rough

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1929	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Sept.		H	M					
505	Metre	600	1097	25	10:10AM	3	20	SE	Overcast	SW	3	Rough
506	Metre	700	1280	25	10:10	3	20	SE	Overcast	SW	3	Rough
507	Metre	700	1280	25	10:10	3	20	SE	Overcast	SW	3	Rough
508	Metre	800	1463	25	10:10	3	20	SE	Overcast	SW	3	Rough
509	Metre	800	1463	25	10:10	3	20	SE	Overcast	SW	3	Rough
510	Metre	2	7	25	10:10	3	20	SE	Overcast	SW	3	Rough
511	Metre	700	1280	27	10:45	3	0	SE	Squally	NW	1	Swell
512	Metre	700	1280	27	10:45	3	0	SE	Squally	NW	1	Swell
513	Metre	700	1280	27	10:45	3	0	SE	Squally	NW	1	Swell
514	Metre	800	1463	27	10:45	3	0	SE	Squally	NW	1	Swell
515	Metre	800	1463	27	10:45	3	0	SE	Squally	NW	1	Swell
516	Metre	1000	1829	27	10:45	3	0	SE	Squally	NW	1	Swell
517	Metre	2	7	27	10:45	3	0	SE	Squally	NW	1	Swell
518	Peters	1000	1829	28	10:26		24	NE	Squally	NE	3	Swell
519	Metre	0–100	183	30	9:06				Clear	N	1	Calm
520	Metre	0–200	366	30					Clear	N	1	Calm
521	Metre	0–300	549	30					Clear	N	1	Calm
522	Metre	0–400	732	30					Clear	N	1	Calm
523	Metre	0–500	914	30					Clear	N	1	Calm
524	Metre	0–600	1097	30					Clear	N	1	Calm
525	Metre	0–700	1280	30					Clear	N	1	Calm
526	Metre	0–800	1463	30					Clear	N	1	Calm
527	Metre	0–900	1646	30					Clear	N	1	Calm
528	Metre	0–1000	1829	30					Clear	N	1	Calm
				1930 Apr.								
529	Metre	0	0	18	7:40PM		20	SE	Clear	W	1	Calm
530	Metre	0	0	19	7:40		35	Circle	No moon	W	1	Calm
531	Metre	0	0	22	7:40		30	Circle	No moon	SW	3	Choppy
532	Metre	0	0	25	7:40		40	Circle	No moon	NE	2	Calm
533	Metre	0	0	26	7:32		40	NW	No moon	E	1	Calm
534	Metre	0	0	29	8:00		20	Circle	Starlight	ENE	4	Choppy
535	Metre	0	0	30	5:00		20	Circle	Clear	SE	2	Choppy
				May								
536	Metre	0	0	2	7:40		30	Circle	Moonlight	SE	4	Choppy
537	Metre	0	0	4	7:45		30	Circle	Moonlight	SW	4	Choppy
538	Metre	500	914	6	9:16AM	3	15	ESE to E	Clear	NE	3	Swell
539	Metre	600	1097	6	9:16	3	15	ESE to E	Clear	NE	3	Swell
540	Metre	700	1280	6	9:16	3	15	ESE to E	Clear	NE	3	Swell
541	Metre	800	1463	6	9:16	3	15	ESE to E	Clear	NE	3	Swell
542	Metre	900	1646	6	9:16	3	15	ESE to E	Clear	NE	3	Swell
543	Metre	1000	1829	6	9:16	3	15	ESE to E	Clear	NE	3	Swell
544	Metre	500	914	7	9:25	3	05	SE to E	Clear	NxE	1	Calm
545	Metre	600	1097	7	9:25	3	05	SE to E	Clear	NxE	1	Calm
546	Metre	1000	1829	7	9:25	3	05	SE to E	Clear	NxE	1	Calm
547	Metre	1100	2011	7	9:25	3	05	SE to E	Clear	NxE	1	Calm
548	Metre	1200	2195	7	9:25	3	05	SE to E	Clear	NxE	1	Calm
549	Metre	0	0	7	9:22	3	00	SE to E	Clear	NxE	1	Calm
550	Metre	0	0	7	10.00PM	2	00	Circle	Moonlight	E	0	Calm
551	Metre	500	914	9	9:35AM	4	00	SE	Clear	SE	1	Calm
552	Metre	600	1097	9	9:35	4	00	SE	Clear	SE	1	Calm

Individual Nets and Data—*Continued*

Net No.	Type of Net	Depth: Fath-oms	Depth: Metres	Date 1930	Start of Haul	Duration of Haul H	Duration of Haul M	Direction of Haul	Weather	Wind: Direction	Wind: Force	Sea
				May		H	M					
553	Metre	700	1280	9	9:35AM	4	00	SE	Clear	SE	1	Calm
554	Metre	800	1463	9	9:35	4	00	SE	Clear	SE	1	Calm
555	Metre	900	1646	9	9:35	4	00	SE	Clear	SE	1	Calm
556	Metre	1000	1829	9	9:35	4	00	SE	Clear	SE	1	Calm
557	Metre	0	0	9	9:20	4	10	SE	Clear	SE	1	Calm
558	Metre	100	183	10	9:05	3	10	ESE	Clear	NW	3	Choppy
559	Metre	200	366	10	9:05	3	10	ESE	Clear	NW	3	Choppy
560	Metre	300	549	10	9:05	3	10	ESE	Clear	NW	3	Choppy
561	Metre	400	732	10	9:05	3	10	ESE	Clear	NW	3	Choppy
562	Metre	500	914	10	9:05	3	10	ESE	Clear	NW	3	Choppy
563	Metre	600	1097	10	9:05	3	10	ESE	Clear	NW	3	Choppy
564	Metre	0	0	10	9:05	3	10	ESE	Clear	NW	3	Choppy
565	Metre	500	914	12	9:11	3	49	SExE	Clear	NW	2	Rough
566	Metre	600	1097	12	9:11	3	49	SExE	Clear	NW	2	Rough
567	Metre	700	1280	12	9:11	3	49	SExE	Clear	NW	2	Rough
568	Metre	800	1463	12	9:11	3	49	SExE	Clear	NW	2	Rough
569	Metre	900	1646	12	9:11	3	49	SExE	Clear	NW	2	Rough
570	Metre	1000	1829	12	9:11	3	49	SExE	Clear	NW	2	Rough
571	Metre	0	0	12	8:45	4	05	SExE	Clear	NW	1	Calm
572	Metre	300	549	14	9:07	4	03	SE	Clear	NW	1	Calm
573	Metre	400	732	14	9:07	4	03	SE	Clear	NW	1	Calm
574	Metre	500	914	14	9:07	4	03	SE	Clear	NW	1	Calm
575	Metre	600	1097	14	9:07	4	03	SE	Clear	NW	1	Calm
576	Metre	700	1280	14	9:07	4	03	SE	Clear	NW	1	Calm
577	Metre	800	1463	14	9:07	4	03	SE	Clear	NW	1	Calm
578	Metre	0	0	14	9:15	3	45	SE	Clear	NW	1	Calm
579	Metre	300	549	15	9:12	3	15	SW	Overcast	S	4	Rough
580	Metre	400	732	15	9:12	3	15	SW	Overcast	S	4	Rough
581	Metre	500	914	15	9:12	3	15	SW	Overcast	S	4	Rough
582	Metre	600	1097	15	9:12	3	15	SW	Overcast	S	4	Rough
583	Metre	700	1280	15	9:12	3	15	SW	Overcast	S	4	Rough
584	Metre	800	1463	15	9:12	3	15	SW	Overcast	S	4	Rough
585	Metre	0	0	15	9:05	3	15	SW	Overcast	S	4	Rough
586	Metre	400	732	17	9:18	4	00	ExS-ExN	Clear	SW	2	Swell
587	Metre	500	914	17	9:18	4	00	ExS-ExN	Clear	SW	2	Swell
588	Metre	600	1097	17	9:18	4	00	ExS-ExN	Clear	SW	2	Swell
589	Metre	700	1280	17	9:18	4	00	ExS-ExN	Clear	SW	2	Swell
590	Metre	800	1463	17	9:18	4	00	ExS-ExN	Clear	SW	2	Swell
591	Metre	900	1646	17	9:18	4	00	ExS-ExN	Clear	SW	2	Swell
592	Metre	0	0	17	9:08	3	07	ExS-ExN	Clear	SW	2	Swell
593	Metre	0	0	17	8:00PM		35	Circle	No moon	W	1	Calm
594	Metre	400	732	19	9:10AM	4	00	SE	Misty	W	1	Choppy
595	Metre	500	914	19	9:10	4	00	SE	Misty	W	1	Choppy
596	Metre	600	1097	19	9:10	4	00	SE	Misty	W	1	Choppy
597	Metre	700	1280	19	9:10	4	00	SE	Misty	W	1	Choppy
598	Metre	800	1463	19	9:10	4	00	SE	Misty	W	1	Choppy
599	Metre	900	1646	19	9:10	4	00	SE	Misty	W	1	Choppy
600	Metre	0	0	19	9:00	3	50	SE	Misty	W	1	Choppy
601	Metre	0	0	19			40		Overcast	W	1	Choppy
602	Metre	200	366	20	9:12	4	00	SW	Overcast	W	3	Choppy
603	Metre	300	549	20	9:12	4	00	SW	Overcast	W	3	Choppy

Individual Nets and Data—*Continued*

Net No.	Type of Net	Depth		Date 1930	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				May		H	M					
604	Metre	400	732	20	9:12AM	4	00	SW	Overcast	W	3	Choppy
605	Metre	500	914	20	9:12	4	00	SW	Overcast	W	3	Choppy
606	Metre	500	914	20	9:12	4	00	SW	Overcast	W	3	Choppy
607	Metre	500	914	20	9:12	4	00	SW	Overcast	W	3	Choppy
608	Metre	0	0	20	9:10	4	00	SW	Overcast	W	3	Choppy
609	Metre	300	549	21	9:30	2	20	ExN	Squally	S	3	Choppy
610	Metre	400	732	21	9:30	2	20	ExN	Squally	S	3	Choppy
611	Metre	500	914	21	9:30	2	20	ExN	Squally	S	3	Choppy
612	Metre	600	1097	21	9:30	2	20	ExN	Squally	S	3	Choppy
613	Metre	600	1097	21	9:30	2	20	ExN	Squally	S	3	Choppy
614	Metre	600	1097	21	9:30	2	20	ExN	Squally	S	3	Choppy
615	Metre	0	0	21	9:30	1	50	ExN	Squally	S	3	Choppy
616	Metre	300	549	22	8:52	4	08	ExS	Clear	N	3	Swell
617	Metre	400	732	22	9:52	4	08	ExS	Clear	N	3	Swell
618	Metre	500	914	22	9:52	4	08	ExS	Clear	N	3	Swell
619	Metre	500	914	22	9:52	4	08	ExS	Clear	N	3	Swell
620	Metre	600	1097	22	8:52	4	08	ExS	Clear	N	3	Swell
621	Metre	600	1097	22	9:52	4	08	ExS	Clear	N	3	Swell
622	Metre	0	0	22	8:51	4	09	ExS	Clear	N	3	Swell
623	Metre	300	549	23	9:11	4	00	SSE-ENE	Clear	N	3	Swell
624	Metre	400	732	23	9:11	4	00	SSE-ENE	Clear	N	3	Swell
625	Metre	500	914	23	9:11	4	00	SSE-ENE	Clear	N	3	Swell
626	Metre	500	914	23	9:11	4	00	SSE-ENE	Clear	N	3	Swell
627	Metre	600	1097	23	9:11	4	00	SSE-ENE	Clear	N	3	Swell
628	Metre	600	1097	23	9:11	4	00	SSE-ENE	Clear	N	3	Swell
629	Metre	0	0	23	9:00	4	10	SSE-ENE	Clear	N	3	Swell
630	Metre	300	549	26	8:56	4	09	SWxS	Misty	S	2	Swell
631	Metre	400	732	26	8:56	4	09	SWxS	Misty	S	2	Swell
632	Metre	500	914	26	8:56	4	09	SWxS	Misty	S	2	Swell
633	Metre	500	914	26	8:56	4	09	SWxS	Misty	S	2	Swell
634	Metre	600	1097	26	8:56	4	09	SWxS	Misty	S	2	Swell
635	Metre	600	1097	26	8:56	4	09	SWxS	Misty	S	2	Swell
636	Metre	0	0	26	8:50	4	10	SWxS	Misty	S	2	Swell
637	Metre	500	914	28	9:01	3	59	SExE	Overcast	WNW	4	Rough
638	Metre	600	1097	28	9:01	3	59	SExE	Overcast	WNW	4	Rough
639	Metre	700	1280	28	9:01	3	59	SExE	Overcast	WNW	4	Rough
640	Metre	800	1463	28	9:01	3	50	SExE	Overcast	WNW	4	Rough
641	Metre	900	1646	28	9:01	3	50	SExE	Overcast	WNW	4	Rough
642	Metre	1000	1829	28	9:01	3	50	SExE	Overcast	WNW	4	Rough
643	Metre	0	0	28	8:45	4	05	SExE	Overcast	WNW	4	Rough
644	Metre	600	1097	29	9:01	3	54	SSW	Clear	WxN	2	Moderate
645	Metre	600	1097	29	9:01	3	54	SSW	Clear	WxN	2	Moderate
646	Metre	600	1097	29	9:01	3	54	SSW	Clear	WxN	2	Moderate
647	Metre	700	1280	29	9:01	3	54	SSW	Clear	WxN	2	Moderate
648	Metre	800	1463	29	9:01	3	54	SSW	Clear	WxN	2	Moderate
649	Metre	900	1646	29	9:01	3	54	SSW	Clear	WxN	2	Moderate
650	Metre	0	0	29	8:40	3	25	SSW	Clear	WxN	2	Moderate
651	Metre	500	914	30	11:10	2	20	SSW	Overcast	S	3	Choppy
652	Metre	500	914	30	11:10	2	20	SSW	Overcast	S	3	Choppy
653	Metre	500	914	30	11:10	2	20	SSW	Overcast	S	3	Choppy
654	Metre	0	0	30	11:15	2	10	SSW	Overcast	S	3	Choppy

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1930	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				June		H	M					
655	Metre	400	732	2	8:57AM	4	03	S	Overcast	SE	3	Choppy
656	Metre	600	1097	2	8:57	4	03	S	Overcast	SE	3	Choppy
657	Metre	700	1280	2	8:57	4	03	S	Overcast	SE	3	Choppy
658	Metre	700	1280	2	8:57	4	03	S	Overcast	SE	3	Choppy
659	Metre	800	1463	2	8:57	4	03	S	Overcast	SE	3	Choppy
660	Metre	900	1646	2	8:57	4	03	S	Overcast	SE	3	Choppy
661	Metre	0	0	2	9:00	3	50	S	Overcast	SE	3	Choppy
662	Metre	0	0	2	8:00		35		Clear	SE	1	Swelly
663	Metre	400	732	4	9:10	4	50	S	Clear	SE	2	Rough
664	Metre	700	1280	4	9:10	4	50	S	Clear	SE	2	Rough
665	Metre	700	1280	4	9:10	4	50	S	Clear	SE	2	Rough
666	Metre	700	1280	4	9:10	4	50	S	Clear	SE	2	Rough
667	Metre	800	1463	4	9:10	4	50	S	Clear	SE	2	Rough
668	Metre	800	1463	4	9:10	4	50	S	Clear	SE	2	Rough
669	Metre	0	0	4	9:20	4	30	S	Clear	SE	2	Rough
670	Metre	0	0	4	9:20	4	30	S	Clear	SE	2	Rough
671	Metre	0–100	0–183	5					Clear	NE	1	Calm
672	Metre	0–200	0–366	5					Clear	NE	1	Calm
673	Metre	0–300	0–549	5					Clear	NE	1	Calm
674	Metre	0–400	0–732	5					Clear	NE	1	Calm
675	Metre	0–500	0–914	5					Clear	NE	1	Calm
676	Metre	0–600	0–1097	5					Clear	NE	1	Calm
677	Metre	0–800	0–1463	5					Clear	NE	1	Calm
678	Metre	0	0	5					Clear	W	1	Calm
679	Metre	400	732	7	9:27	4	04	SW	Clear	W	1	Calm
680	Metre	700	1280	7	9:27	4	04	SW	Clear	W	1	Calm
681	Metre	700	1280	7	9:27	4	04	SW	Clear	W	1	Calm
682	Metre	800	1463	7	9:27	4	04	SW	Clear	W	1	Calm
683	Metre	900	1646	7	9:27	4	04	SW	Clear	W	1	Calm
684	Metre	1000	1829	7	9:27	4	04	SW	Clear	W	1	Calm
685	Metre	700	1280	9	9:30	4	50	SSE to E	Clear	E	1	Calm
686	Metre	800	1463	9	9:30	4	50	SSE to E	Clear	E	1	Calm
687	Metre	900	1646	9	9:30	4	50	SSE to E	Clear	E	1	Calm
688	Metre	1000	1829	9	9:30	4	50	SSE to E	Clear	E	1	Calm
689	Metre	1000	1829	9	9:30	4	50	SSE to E	Clear	E	1	Calm
690	Metre	1000	1829	9	9:30	4	50	SSE to E	Clear	E	1	Calm
691	Metre	700	1280	12	9:34	4	34	E	Overcast	E	3	Moderate
692	Metre	800	1463	12	9:34	4	34	E	Overcast	E	3	Moderate
693	Metre	900	1646	12	9:34	4	34	E	Overcast	E	3	Moderate
694	Metre	900	1646	12	9:34	4	34	E	Overcast	E	3	Moderate
695	Metre	1000	1829	12	9:34	4	34	E	Overcast	E	3	Moderate
696	Metre	1000	1829	12	9:34	4	34	E	Overcast	E	3	Moderate
697	Metre	0	0	12	9:35	4	30	E	Overcast	E	3	Moderate
698	Metre	700	1280	13	9:35	4	00	ESE	Overcast	SE	3	Rough
699	Metre	700	1280	13	9:35	4	00	ESE	Overcast	SE	3	Rough
700	Metre	800	1463	13	9:35	4	00	ESE	Overcast	SE	3	Rough
701	Metre	800	1463	13	9:35	4	00	ESE	Overcast	SE	3	Rough
702	Metre	900	1646	13	9:35	4	00	ESE	Overcast	SE	3	Rough
703	Metre	900	1646	13	9:35	4	00	ESE	Overcast	SE	3	Rough
704	Metre	0	0	13	9:40	3	35	ESE	Overcast	SE	3	Rough
705	Metre	0	0	12	8:00PM		30		No moon			

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth Fathoms	Depth Metres	Date 1930	Start of Haul	Duration of Haul H	M	Direction of Haul	Weather	Wind Direction	Wind Force	Sea
				June		H	M					
706	Metre	0	0	15	8:00PM		30					
707	Metre	500	914	16	9:15AM	3	45	E	Clear	E	2	Rough
708	Metre	500	914	16	9:15	3	45	E	Clear	E	2	Rough
709	Metre	700	1280	16	9:15	3	45	E	Clear	E	2	Rough
710	Metre	700	1280	16	9:15	3	45	E	Clear	E	2	Rough
711	Metre	800	1463	16	9:15	3	45	E	Clear	E	2	Rough
712	Metre	800	1463	16	9:15	3	45	E	Clear	E	2	Rough
713	Metre	700	1280	17	9:16	3	44	E	Clear	E	2	Swell
714	Metre	700	1280	17	9:16	3	44	E	Clear	E	2	Swell
715	Metre	800	1463	17	9:16	3	44	E	Clear	E	2	Swell
716	Metre	900	1646	17	9:16	3	44	E	Clear	E	2	Swell
717	Metre	900	1646	17	9:16	3	44	E	Clear	E	2	Swell
718	Metre	1000	1829	17	9:16	3	44	E	Clear	E	2	Swell
719	Metre	700	1280	25	9:20	4	40	ESE	Clear	SE	1	Swell
720	Metre	800	1463	25	9:20	4	40	ESE	Clear	SE	1	Swell
721	Metre	900	1646	25	9:20	4	40	ESE	Clear	SE	1	Swell
722	Metre	900	1646	25	9:20	4	40	ESE	Clear	SE	1	Swell
723	Metre	1000	1829	25	9:20	4	40	ESE	Clear	SE	1	Swell
724	Metre	1000	1829	25	9:20	4	40	ESE	Clear	SE	1	Swell
725	Metre	500	914	26	9:16	4	51		Overcast	SW	3	Swell
726	Metre	800	1463	26	9:16	4	51		Overcast	SW	3	Swell
727	Metre	900	1646	26	9:16	4	51		Overcast	SW	3	Swell
728	Metre	900	1646	26	9:16	4	51		Overcast	SW	3	Swell
729	Metre	1000	1829	26	9:16	4	51		Overcast	SW	3	Swell
730	Metre	1000	1829	26	9:16	4	51		Overcast	SW	3	Swell
731	Metre	800	1463	27	9:10	5	00	SW	Misty	SW	1	Swell
732	Metre	900	1646	27	9:10	5	00	SW	Misty	SW	1	Swell
733	Metre	900	1646	27	9:10	4	00	SW	Misty	SW	1	Swell
734	Metre	1000	1829	27	9:10	4	00	SW	Misty	SW	1	Swell
735	Metre	1000	1829	27	9:10	4	00	SW	Misty	SW	1	Swell
736	Metre	1000	1829	27	9:10	4	00	SW	Misty	SW	1	Swell
737	Metre	0	0	26	8:00PM		30	SW	No moon	SW	1	Choppy
738	Metre	800	1463	28	9:07AM	4	49	E	Overcast	S	1	Swell
739	Metre	900	1646	28	9:07	4	49	E	Overcast	S	1	Swell
740	Metre	900	1646	28	9:07	4	49	E	Overcast	S	1	Swell
741	Metre	1000	1829	28	9:07	4	49	E	Overcast	S	1	Swell
742	Metre	1000	1829	28	9:07	4	49	E	Overcast	S	1	Swell
743	Metre	1000	1829	28	9:07	4	49	E	Overcast	S	1	Swell
744	Metre	0	0	28	9:20PM		40	SE	No moon	SW	2	Choppy
745	Metre	0	0	29	8:10		35		No moon	SW	2	Swell
746	Metre	800	1463	30	9:19AM	4	41	E	Clear	S	1	Calm
747	Metre	900	1646	30	9:19	4	41	E	Clear	S	1	Calm
748	Metre	900	1646	30	9:19	4	41	E	Clear	S	1	Calm
749	Metre	1000	1829	20	9:19	4	41	E	Clear	S	1	Calm
750	Metre	1000	1829	20	9:19	4	41	E	Clear	S	1	Calm
751	Metre	1000	1829	20	9:19	4	41	E	Clear	S	1	Calm
				July								
752	Metre	500	914	1	9:00	4	45	SW	Clear	SW	1	Calm
753	Metre	700	1280	1	9:00	4	45	SW	Clear	SW	1	Calm
754	Metre	700	1280	1	9:00	4	45	SW	Clear	SW	1	Calm
755	Metre	800	1463	1	9:00	4	45	SW	Clear	SW	1	Calm

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth Fathoms	Depth Metres	Date 1930	Start of Haul	Duration of Haul H	Duration of Haul M	Direction of Haul	Weather	Wind Direction	Wind Force	Sea
				July		H	M					
756	Metre	1000	1829	1	9:00AM	4	45	SW	Clear	SW	1	Calm
757	Metre	1000	1829	1	9:00	4	45	SW	Clear	SW	1	Calm
758	Metre	500	914	2	9:42	4	20	WxS	Overcast	S	3	Swell
759	Metre	700	1280	2	9:42	4	20	WxS	Overcast	S	3	Swell
760	Metre	800	1463	2	9:42	4	20	WxS	Overcast	S	3	Swell
761	Metre	900	1646	2	9:42	4	20	WxS	Overcast	S	3	Swell
762	Metre	1000	1829	2	9:42	4	20	WxS	Overcast	S	3	Swell
763	Metre	300	549	3	11:15	3	00	E	Squally	S	2	Choppy
764	Metre	400	732	3	11:15	3	00	E	Squally	S	2	Choppy
765	Metre	500	914	3	11:15	3	00	E	Squally	S	2	Choppy
766	Metre	500	914	3	11:15	3	00	E	Squally	S	2	Choppy
767	Metre	800	1463	3	11:15	3	00	E	Squally	S	2	Choppy
768	Metre	800	1463	3	11:15	3	00	E	Squally	S	2	Choppy
769	Metre	0	0	3	9:00PM		40	E	Overcast	SW	2	Choppy
770	Metre	700	1280	4	9:40	4	20	SW	Cloudy	SW	2	Choppy
771	Metre	900	1646	4	9:40	4	20	SW	Cloudy	SW	2	Choppy
772	Metre	900	1646	4	9:40	4	20	SW	Cloudy	SW	2	Choppy
773	Metre	1000	1829	4	9:40	4	20	SW	Cloudy	SW	2	Choppy
774	Metre	1000	1829	4	9:40	4	20	SW	Cloudy	SW	2	Choppy
775	Metre	1000	1829	4	9:40	4	20	SW	Cloudy	SW	2	Choppy
776	Metre	500	914	5	9:04	5	21	S	Squally	SW	3	Choppy
777	Metre	600	1097	5	9:04	5	21	S	Squally	SW	3	Choppy
778	Metre	700	1280	5	9:04	5	21	S	Squally	SW	3	Choppy
779	Metre	800	1463	5	9:04	5	21	S	Squally	SW	3	Choppy
780	Metre	900	1646	5	9:04	5	21	S	Squally	SW	3	Choppy
781	Metre	1000	1829	5	9:04	5	21	S	Squally	SW	3	Choppy
782	Metre	0	0	5	10:00PM	2	00	Circle	Moonlight	SW	1	Choppy
783	#20D	0	0	5	10:00	2	00	Circle	Moonlight	SW	1	Choppy
784	Metre	500	914	7	9:30AM	4	30	E	Squally	SW	1	Choppy
785	Metre	600	1097	7	9:30	4	30	E	Squally	SW	1	Choppy
786	Metre	700	1280	7	9:30	4	30	E	Squally	SW	1	Choppy
787	Metre	800	1463	7	9:30	4	30	E	Squally	SW	1	Choppy
788	Metre	900	1646	7	9:30	4	30	E	Squally	SW	1	Choppy
789	Metre	1000	1829	7	9:30	4	30	E	Squally	SW	1	Choppy
790	Metre	0	0	8	8:30PM		20	ESE	Moonlight	SW	2	Choppy
791	Metre	500	914	9	9:34AM	4	26	SW	Overcast	SW	2	Swell
792	Metre	600	1097	9	9:34	4	26	SW	Overcast	SW	2	Swell
793	Metre	700	1280	9	9:34	4	26	SW	Overcast	SW	2	Swell
794	Metre	800	1463	9	9:34	4	26	SW	Overcast	SW	2	Swell
795	Metre	900	1646	9	9:34	4	26	SW	Overcast	SW	2	Swell
796	Metre	1000	1829	9	9:34	4	26	SW	Overcast	SW	2	Swell
797	Metre	500	914	15	9:37	4	23	SSW	Clear	SW	3	Moderate
798	Metre	600	1097	15	9:37	4	23	SSW	Clear	SW	3	Moderate
799	Metre	700	1280	15	9:37	4	23	SSW	Clear	SW	3	Moderate
800	Metre	800	1463	15	9:37	4	23	SSW	Clear	SW	3	Moderate
801	Metre	900	1646	15	9:37	4	23	SSW	Clear	SW	3	Moderate
802	Metre	1000	1829	15	9:37	4	23	SSW	Clear	SW	3	Moderate
803	Metre	0	0	15	8:00PM		40	E	No moon	SW	2	Calm
804	Metre	500	914	16	9:22AM	4	38	SW	Overcast	SW	1	Moderate
805	Metre	600	1097	16	9:22	4	38	SW	Overcast	SW	1	Moderate
806	Metre	700	1280	16	9:22	4	38	SW	Overcast	SW	1	Moderate

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1930	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres			H	M			Direction	Force	
				July								
807	Metre	800	1463	16	9:22AM	4	38	SW	Overcast	SW	1	Moderate
808	Metre	900	1646	16	9:22	4	38	SW	Overcast	SW	1	Moderate
809	Metre	1000	1829	16	9:22	4	38	SW	Overcast	SW	1	Moderate
				Aug.								
810	Metre	600	1097	28	9:16	4	14	E	Clear	S	1	Calm
811	Metre	600	1097	28	9:16	4	14	E	Clear	S	1	Calm
812	Metre	600	1097	28	9:16	4	14	E	Clear	S	1	Calm
813	Metre	700	1280	28	9:16	4	14	E	Clear	S	1	Calm
814	Metre	800	1463	28	9:16	4	14	E	Clear	S	1	Calm
815	Metre	900	1646	28	9:16	4	14	E	Clear	S	1	Calm
816	Metre	600	1097	29	9:23	3	42	SW	Squally	SW	3	Rough
817	Metre	600	1097	29	9:23	3	42	SW	Squally	SW	3	Rough
818	Metre	600	1097	29	9:23	3	42	SW	Squally	SW	3	Rough
819	Metre	800	1463	29	9:23	3	42	SW	Squally	SW	3	Rough
820	Metre	900	1646	29	9:23	3	42	SW	Squally	SW	3	Rough
821	Metre	0	0	29	8:20PM		40	S	Moonlight	SW	2	Swell
				Sept.								
822	Metre	600	1097	1	9:35	4	25	E	Clear	E	2	Moderate
823	Metre	700	1280	1	9:35	4	25	E	Clear	E	2	Moderate
824	Metre	800	1463	1	9:35	4	25	E	Clear	E	2	Moderate
825	Metre	800	1463	1	9:35	4	25	E	Clear	E	2	Moderate
826	Metre	900	1646	1	9:35	4	25	E	Clear	E	2	Moderate
827	Metre	1000	1829	1	9:35	4	25	E	Clear	E	2	Moderate
828	Metre	500	914	2	9:27	4	03	NxE	Overcast	E	3	Moderate
829	Metre	600	1097	2	9:27	4	03	NxE	Overcast	E	3	Moderate
830	Metre	700	1280	2	9:27AM	4	03	NxE	Overcast	E	3	Moderate
831	Metre	900	1646	2	9:27	4	03	NxE	Overcast	E	3	Moderate
832	Metre	900	1646	2	9:27	4	03	NxE	Overcast	E	3	Moderate
833	Metre	1000	1829	2	9:27	4	03	NxE	Overcast	E	3	Moderate
834	Metre	400	732	3	9:01	4	44	ExN	Clear	N	1	Calm
835	Metre	500	914	3	9:01	4	44	ExN	Clear	N	1	Calm
836	Metre	500	914	3	9:01	4	44	ExN	Clear	N	1	Calm
837	Metre	600	1097	3	9:01	4	44	ExN	Clear	N	1	Calm
838	Metre	600	1097	3	9:01	4	44	ExN	Clear	N	1	Calm
839	Metre	700	1280	3	9:01	4	44	ExN	Clear	N	1	Calm
840	Metre	0	0	3	8:10PM		40	NW	Clear	W	1	Calm
841	Metre	500	914	4	9:34AM	3	56	SW	Overcast	W	1	Calm
842	Metre	600	1097	4	9:34	3	56	SW	Overcast	W	1	Calm
843	Metre	700	1280	4	9:34	3	56	SW	Overcast	W	1	Calm
844	Metre	800	1463	4	9:34	3	56	SW	Overcast	W	1	Calm
845	Metre	900	1646	4	9:34	3	56	SW	Overcast	W	1	Calm
846	Metre	1000	1829	4	9:34	3	56	SW	Overcast	W	1	Calm
847	Metre	500	914	5	9:13	4	22	NE	Squally	NW	3	Calm
848	Metre	600	1097	5	9:13	4	22	NE	Squally	NW	3	Calm
849	Metre	700	1280	5	9:13	4	22	NE	Squally	NW	3	Calm
850	Metre	800	1463	5	9:13	4	22	NE	Squally	NW	3	Calm
851	Metre	900	1646	5	9:13	4	22	NE	Squally	NW	3	Calm
852	Metre	1000	1829	5	9 13	4	22	NE	Squally	NW	3	Calm
853	Metre	500	914	6	9:07	4	23	ESE	Clear	NW	1	Calm
854	Metre	600	1097	6	9:07	4	23	ESE	Clear	NW	1	Calm
855	Metre	700	1280	6	9:07	4	23	ESE	Clear	NW	1	Calm

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1930	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Sept.		H	M					
856	Metre	800	1463	6	9:07AM	4	23	ESE	Clear	NW	1	Calm
857	Metre	900	1646	6	9:07	4	23	ESE	Clear	NW	1	Calm
858	Metre	1000	1829	6	9:07	4	23	ESE	Clear	NW	1	Calm
859	Metre	500	914	8	9:29	4	01	SWxW	Overcast	SW	3	Swell
860	Metre	600	1097	8	9:29	4	01	SWxW	Overcast	SW	3	Swell
861	Metre	700	1280	8	9:29	4	01	SWxW	Overcast	SW	3	Swell
862	Metre	800	1463	8	9:29	4	01	SWxW	Overcast	SW	3	Swell
863	Metre	900	1646	8	9:29	4	01	SWxW	Overcast	SW	3	Swell
864	Metre	1000	1829	8	9:29	4	01	SWxW	Overcast	SW	3	Swell
865	Metre	600	1097	10	9:38	2	52	SW	Overcast	SW	3	Swell
866	Metre	700	1280	10	9:38	2	52	SW	Overcast	SW	3	Swell
867	Metre	800	1463	10	9:38	2	52	SW	Overcast	SW	3	Swell
868	Metre	900	1646	10	9:38	2	52	SW	Overcast	SW	3	Swell
869	Metre	1000	1829	10	9:38	2	52	SW	Overcast	SW	3	Swell
870	Metre	100	183	11	10:03	2	27	E-NE-E	Squally	NE	1	Calm
871	Metre	200	366	11	10:03	2	27	E-NE-E	Squally	NE	1	Calm
872	Metre	300	549	11	10:03	2	27	E-NE-E	Squally	NE	1	Calm
873	Metre	400	732	11	10:03	2	27	E-NE-E	Squally	NE	1	Calm
874	Metre	500	914	11	10 03	2	27	E-NE-E	Squally	NE	1	Calm
875	Metre	600	1097	11	10:03	2	27	E-NE-E	Squally	NE	1	Calm
876	Metre	100	183	12	11:22	3	00	ExN	Squally	N	1	Calm
877	Metre	200	366	12	11:22	3	00	ExN	Squally	N	1	Calm
878	Metre	300	549	12	11:22	3	00	ExN	Squally	N	1	Calm
879	Metre	400	732	12	11:22	3	00	ExN	Squally	N	1	Calm
880	Metre	500	914	12	11:22	3	00	ExN	Squally	N	1	Calm
881	Metre	600	1097	12	11:22	3	00	ExN	Squally	N	1	Calm
882	Metre	700	1280	13	9:33	4	27	SWxW	Overcast	W	3	Swell
883	Metre	700	1280	13	9:33	4	27	SWxW	Overcast	W	3	Swell
884	Metre	800	1463	13	9:33	4	27	SWxW	Overcast	W	3	Swell
885	Metre	800	1463	13	9:33	4	27	SWxW	Overcast	W	3	Swell
886	Metre	900	1646	13	9:33	4	27	SWxW	Overcast	W	3	Swell
887	Metre	900	1646	13	9:33	4	27	SWxW	Overcast	W	3	Swell
888	Metre	400	732	15	9:20	4	00	SWxW	Squally	NW	3	Rough
889	Metre	500	914	15	9:20	4	00	SWxW	Squally	NW	3	Rough
890	Metre	600	1097	15	9:20	4	00	SWxW	Squally	NW	3	Rough
891	Metre	700	1280	15	9:20	4	00	SWxW	Squally	NW	3	Rough
892	Metre	800	1463	15	9:20	4	00	SWxW	Squally	NW	3	Rough
893	Metre	900	1646	15	9:20	4	00	SWxW	Squally	NW	3	Rough
894	Metre	500	914	16	9:29	4	26	SSE	Clear	NW	3	Calm
895	Metre	600	1097	16	9:29	4	26	SSE	Clear	NW	3	Calm
896	Metre	700	1280	16	9:29	4	26	SSE	Clear	NW	3	Calm
897	Metre	800	1463	16	9:29	4	26	SSE	Clear	NW	3	Calm
898	Metre	900	1646	16	9:29	4	26	SSE	Clear	NW	3	Calm
899	Metre	1000	1829	16	9:29	4	26	SSE	Clear	NW	3	Calm
900	Metre	0	0	16	8:00PM	1	00	S	Clear	N	2	Calm
901	Metre	600	1097	17	9:10AM	4	05	SWxW	Clear	E	2	Calm
902	Metre	700	1280	17	9:10	4	05	SWxW	Clear	E	2	Calm
903	Metre	800	1463	17	9:10	4	05	SWxW	Clear	E	2	Calm
904	Metre	900	1646	17	9:10	4	05	SWxW	Clear	E	2	Calm
905	Metre	900	1646	17	9:10	4	05	SWxW	Clear	E	2	Calm
906	Metre	800	1463	17	9:10	4	05	SWxW	Clear	E	2	Calm

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1930	Start of Haul	Duration of Haul	Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres	Sept.		H M			Direction	Force	
907	Metre	0-100	0–183	18	1:40PM	10		Clear	NE	2	Calm
908	Metre	0-200	0–366	18	1:57	15		Clear	NE	2	Calm
909	Metre	0-300	0–549	18	2:23	20		Clear	NE	2	Calm
910	Metre	0-400	0–732	18	2:51	28		Clear	NE	2	Calm
911	Metre	0-500	0–914	18	8:21AM	41		Clear	NE	2	Calm
912	Metre	0-600	0–1097	18	9:17	48		Clear	NE	2	Calm
913	Metre	0-800	0–1463	18	10:20	1 00		Clear	NE	2	Calm
914	Metre	0-1000	0–1829	18	11:37	1 36		Clear	NE	2	Calm
915	Metre	500	914	19	9:15	4 30	SE	Clear	NW	1	Calm
916	Metre	500	914	19	9:15	4 30	SE	Clear	NW	1	Calm
917	Metre	600	1097	19	9:15	4 30	SE	Clear	NW	1	Calm
918	Metre	700	1280	19	9:15	4 30	SE	Clear	NW	1	Calm
919	Metre	700	1280	19	9:15	4 30	SE	Clear	NW	1	Calm
920	Metre	0	0	19	9:15	4 30	SE	Clear	NW	1	Calm
921	Metre	500	914	20	9:20	3 55	SW	Squally	NW	2	Moderate
922	Metre	600	1097	20	9:20	3 55	SW	Squally	NW	2	Moderate
923	Metre	600	1097	20	9:20	3 55	SW	Squally	NW	2	Moderate
924	Metre	800	1463	20	9:20	3 55	SW	Squally	NW	2	Moderate
925	Metre	900	1646	20	9:20	3 55	SW	Squally	NW	2	Moderate
926	Metre	900	1646	20	9:20	3 55	SW	Squally	NW	2	Moderate
927	Metre	500	914	22	10:33	3 27	NExN	Clear	NW	2	Choppy
928	Metre	500	914	22	10:33	3 27	NExN	Clear	NW	2	Choppy
929	Metre	700	1280	22	10:33	3 27	NExN	Clear	NW	2	Choppy
930	Metre	700	1280	22	10:33	3 27	NExN	Clear	NW	2	Choppy
931	Metre	800	1463	22	10:33	3 27	NExN	Clear	NW	2	Choppy
932	Metre	900	1646	22	10:33	3 27	NExN	Clear	N	2	Moderate
933	Metre	600	1097	23	9:10	4 00	SW	Clear	N	1	Moderate
934	Metre	700	1280	23	9:10	4 00	SW	Clear	N	1	Moderate
935	Metre	800	1463	23	9:10	4 00	SW	Clear	N	1	Moderate
936	Metre	1000	1829	23	9:10	4 00	SW	Clear	N	1	Moderate
937	Metre	400	732	24	9:35	3 45	SSW	Misty	NE	2	Choppy
938	Metre	500	914	24	9:35	3 45	SSW	Misty	NE	2	Choppy
939	Metre	1000	1829	24	9:35	3 45	SSW	Misty	NE	2	Choppy
940	Metre	1000	1829	24	9:35	3 45	SSW	Misty	NE	2	Choppy
941	Metre	1000	1829	24	9:35	3 45	SSW	Misty	NE	2	Choppy
942	Metre	1000	1829	24	9:35	3 45	SSW	Misty	NE	2	Choppy
943	Metre	300	549	25	12:41PM	1 23	ESE	Overcast	N	2	Calm
944	Metre	400	732	25	12:41	1 23	ESE	Overcast	N	2	Calm
945	Metre	500	914	25	12:41	1 23	ESE	Overcast	N	2	Calm
946	Metre	600	1097	25	12:41	1 23	ESE	Overcast	N	2	Calm
947	Metre	700	1280	25	12:41	1 23	ESE	Overcast	N	2	Calm
948	Metre	400	732	26	9:34AM	3 43	SWxS	Overcast	W	1	Moderate
949	Metre	800	1463	26	9:34	3 43	SWxS	Overcast	W	1	Moderate
950	Metre	900	1646	26	9:34	3 54	SWxS	Overcast	W	1	Moderate
951	Metre	900	1646	26	9:34	3 54	SWxS	Overcast	W	1	Moderate
952	Metre	1000	1829	26	9:34	3 54	SWxS	Overcast	W	1	Moderate
953	Metre	1000	1829	26	9:34	3 54	SWxS	Overcast	W	1	Moderate
954	Metre	1000	1829	26	9:34	3 54	SWxS	Overcast	W	1	Moderate
955	4'Dr	1000	3000	28	9:15	2 15	S	Clear	NE	1	Calm
956	4'Dr	1000	3000	28	12:45PM	2 21	SE	Clear	NE	1	Calm
957	Metre	300	549	29	9:36AM	3 54	SE to S	Squally	N	1	Calm

INDIVIDUAL NETS AND DATA—*Continued*

Net No.	Type of Net	Depth		Date 1930	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres			H	M			Direction	Force	
				Sept.								
958	Metre	400	732	29	9:36AM	3	54	SE to S	Squally	N	1	Calm
959	Metre	500	914	29	9:36	3	54	SE to S	Squally	N	1	Calm
960	Metre	600	1097	29	9:36	3	54	SE to S	Squally	N	1	Calm
961	Metre	700	1280	29	9:36	3	54	SE to S	Squally	N	1	Calm
962	Metre	800	1463	29	9:36	3	54	SE to S	Squally	N	1	Calm
963	Metre	900	1646	29	9:36	3	54	SE to S	Squally	N	1	Calm
964	1 Diat	600	1097	29	9:36	3	54	SE to S	Squally	N	1	Calm
965	Metre	300	549	30	9:30	4	30	E to N	Clear	SE	1	Calm
966	Metre	400	732	30	9:30	4	30	E to N	Clear	SE	1	Calm
967	Metre	500	914	30	9:30	4	30	E to N	Clear	SE	1	Calm
968	Metre	700	1280	30	9:30	4	30	E to N	Clear	SE	1	Calm
969	Metre	800	1463	30	9:30	4	30	E to N	Clear	SE	1	Calm
970	Metre	1000	1829	30	9:30	4	30	E to N	Clear	SE	1	Calm
971	Metre	1000	1829	30	9:30	4	30	E to N	Clear	SE	1	Calm
972	1 Diat.	900	1646	30	9:30	4	30	E to N	Clear	SE	1	Calm
973		0	0	30	9:30	4	30	E to N	Clear	SE	1	Calm
				Oct.								
974	½Metre	100	183	8	10:24		40	E	Clear	NNE	2	Rough
975	Metre	0	0	12	9:00	3	00	E	Clear	NE	1	Moderate
976	Metre	0	0	12	2:00	2	00	E	Clear	NE	1	Moderate

New York Zoological Society

OBJECTS OF THE SOCIETY

A Public Zoological Park. A Public Aquarium. The Preservation of our Native Animals. The Promotion of Zoology.

ZOOLOGICA VOL. I

		Paper	Cloth
Parts 1–20	*Not bound*	3.85	
Parts 1–20	*Bound*		6.00

ZOOLOGICA VOL. II

Parts 1–18	*Not bound*	4.30	
Parts 1–18	*Bound*		6.50

Postage weight, 4 pounds

ZOOLOGICA VOL. III

Parts 1–23	*Not bound*	3.25	
Parts 1–23	*Bound*		5.00

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ZOOLOGICA

SCIENTIFIC CONTRIBUTIONS OF THE NEW YORK ZOOLOGICAL SOCIETY

VOLUME XIII. NUMBER 3

BERMUDA OCEANOGRAPHIC EXPEDITIONS 1931

INDIVIDUAL NETS AND DATA

By William Beebe

PUBLISHED BY THE SOCIETY
THE ZOOLOGICAL PARK, NEW YORK

March, 1932

BERMUDA OCEANOGRAPHIC EXPEDITIONS

INDIVIDUAL NETS AND DATA*

1931

By William Beebe

Nets by Vertical Distribution—1931

	May	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Total*
Surface	6	6	1	4	2	..	8	27
25	..	3	4	..	2	..	..	9
50	..	2	8	..	4	..	..	14
100	..	3	5	..	3	..	..	11
200	..	4	4	..	1	..	..	9
300	..	6	23	2	5	..	..	36
400	..	3	5	9	3	..	..	20
500	...	7	3	18	10	2	..	40
600	..	6	4	16	10	2	..	38
700	..	7	3	18	10	2	..	40
800	..	7	3	20	10	2	..	42
900	..	6	4	17	10	2	..	39
1000	..	5	3	23	10	2	..	43
1100	..	..	..	..	1	..	..	1
1200	..	..	..	..	..	..	..	..
1300	..	..	..	..	..	..	..	..
1400	..	1	..	..	..	..	..	1
1500	..	..	..	1	2	..	..	3
2000	..	..	..	..	1	..	..	1
TOTAL	6	66	70	128	84	12	8	374

General Summary of Vertical Distribution of 1350 Nets (1929, 1930, 1931)

Surface	113	800	174
25	9	900	174
50	14	1000	178
100	21	1100	5
200	21	1200	1
300	59	1400	1
400	60	1500	3
500	172	2000	1
600	172		
700	172	TOTAL	1350

*Contribution, New York Zoological Society, Department of Tropical Research, No. 366.

INDIVIDUAL NETS AND DATA

Net No.	Type of Net	Depth: Fathoms	Depth: Metres	Date 1931	Start of Haul	Duration of Haul: H	Duration of Haul: M	Direction of Haul	Weather	Wind: Direction	Wind: Force	Sea
				May		H	M					
977	Metre	0	0	12	8:05PM		25	S to SE	Overcast	E	1	Swell
978	Metre	0	0	15	8:15		25	SE	No moon	SE	3	Choppy
979	Metre	0	0	16	8:10		20	S to N	No moon	SE	1	Calm
980	Metre	0	0	17	8:05	1	0	S to N	No moon	SE	1	Choppy
981	Metre	0	0	18	9:55		30	SE	No moon	O	0	Calm
982	Metre	0	0	19	9:00		30	NW	No moon	SE	2	Choppy
				June								
983	Metre	500	914	2	10:00AM	4	1	SE	Clear	SW	4	Choppy
984	Metre	600	1097	2	10:00	4	1	SE	Clear	SW	4	Choppy
985	Metre	700	1280	2	10:00	4	1	SE	Clear	SW	4	Choppy
986	Metre	800	1463	2	10:00	4	1	SE	Clear	SW	4	Choppy
987	Metre	900	1646	2	10:00	4	1	SE	Clear	SW	4	Choppy
988	Metre	1000	1829	2	10:00	4	1	SE	Clear	SW	4	Choppy
989	Metre	0	0	3	8:25PM		35	SE	No moon	NxE	3	Choppy
990	Metre	500	914	4	9:30AM	4	5	E	Clear	N	2	Moderate
991	Metre	600	1097	4	9:30	4	5	E	Clear	N	2	Moderate
992	Metre	700	1280	4	9:30	4	5	E	Clear	N	2	Moderate
993	Metre	800	1463	4	9:30	4	5	E	Clear	N	2	Moderate
994	Metre	900	1646	4	9:30	4	5	E	Clear	N	2	Moderate
995	Metre	1000	1829	4	9:30	4	5	E	Clear	N	2	Moderate
996	Metre	400	732	5	9:15	4	10	SxW	Clear	W	2	Moderate
997	Metre	500	914	5	9:15	4	10	SxW	Clear	W	2	Moderate
998	Metre	600	1097	5	9:15	4	10	SxW	Clear	W	2	Moderate
999	Metre	700	1280	5	9:15	4	10	SxW	Clear	W	2	Moderate
1000	Metre	700	1280	5	9:15	4	10	SxW	Clear	W	2	Moderate
1001	Metre	800	1463	5	9:15	4	10	SxW	Clear	W	2	Moderate
1002	Metre	300	549	6	9:20	4	10	SSW	Clear	NW	3	Moderate
1003	Metre	500	914	6	9:20	4	10	SSW	Clear	NW	3	Moderate
1004	Metre	600	1097	6	9:20	4	10	SSW	Clear	NW	3	Moderate
1005	Metre	700	1280	6	9:20	4	10	SSW	Clear	NW	3	Moderate
1006	Metre	800	1463	6	9:20	4	10	SSW	Clear	NW	3	Moderate
1007	Metre	800	1463	6	9:20	4	10	SSW	Clear	NW	3	Moderate
1008	Metre	600	1097	11	9:20	3	50	E	Overcast	SW	4	Choppy
1009	Metre	900	1646	11	9:20	3	50	E	Overcast	SW	4	Choppy
1010	Metre	900	1646	11	9:20	3	50	E	Overcast	SW	4	Choppy
1011	Metre	1000	1829	11	9:20	3	50	E	Overcast	SW	4	Choppy
1012	Metre	1000	1829	11	9:20	3	50	E	Overcast	SW	4	Choppy
1013	{Wire Metre	400	732	12	9:00	1		SSE	Overcast	NW	5	Rough
1014	{Wire Metre	500	914	13	9:00	1	25	ESE	Overcast	W	4	Rough
1015	Metre	500	914	15	9:45	4	5	SSW	Overcast	NW	4	Choppy
1016	Metre	500	914	15	9:45	4	5	SSW	Overcast	NW	4	Choppy
1017	Metre	900	1646	15	9:45	4	5	SSW	Overcast	NW	4	Choppy
1018	Metre	900	1646	15	9:45	4	5	SSW	Overcast	NW	4	Choppy
1019	Metre	1000	1829	15	9:45	4	5	SSW	Overcast	NW	4	Choppy
1020	Metre	1400	2562	15	9:45	4	5	SSW	Overcast	NW	4	Choppy
1021	Metre	600	1097	16	9:17	4	0	SE	Overcast	NW	1	Calm
1022	Metre	700	1280	16	9:17	4	0	SE	Overcast	NW	1	Calm
1023	Metre	700	1280	16	9:17	4	0	SE	Overcast	NW	1	Calm

Individual Nets and Data — *Continued*

Net No.	Type of Net	Depth		Date 1931	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres			H	M			Direction	Force	
				June								
1024	Metre	800	1463	16	9:17AM	4	0	SE	Overcast	NW	1	Calm
1025	Metre	800	1463	16	9:17	4	0	SE	Overcast	NW	1	Calm
1026	Metre	1000	1829	16	9:17	4	0	SE	Overcast	NW	1	Calm
1027	Metre	0	0	17	8:30PM		40	N	Overcast	SW	2	Choppy
1028	Metre	0	0	20	9:20		30	SW	Moonlight	O	0	Calm
1029	{Wire 2 Metre	200	366	22	10:30AM	1	50	NW	Clear	SW	1	Calm
1030	{Wire 2 Metre	400	732	22	1:20PM	1	25	SE	Clear	SW	1	Calm
1031	Metre	0	0	23	9:08AM	5	0	SW	Clear	SW	1	Calm
1032	Metre	25	45	23	9:08	5	0	SW	Clear	SW	1	Calm
1033	Metre	200	366	23	9:08	5	0	SW	Clear	SW	1	Calm
1034	Metre	300	549	23	9:08	5	0	SW	Clear	SW	1	Calm
1035	Metre	100	183	25	9:06	4	39	SW	Clear	NW	4	Choppy
1036	Metre	200	366	25	9:06	4	39	SW	Clear	NW	4	Choppy
1037	Metre	300	549	25	9:06	4	39	SW	Clear	NW	4	Choppy
1038	Metre	300	549	25	9:06	4	39	SW	Clear	NW	4	Choppy
1039	Metre	0	0	26	8:50	4	10	ESE	Overcast	E	4	Rough
1040	Metre	25	45	26	8:50	4	10	ESE	Overcast	E	4	Rough
1041	Metre	50	92	26	8:50	4	10	ESE	Overcast	E	4	Rough
1042	Metre	100	183	26	8:50	4	10	ESE	Overcast	E	4	Rough
1043	Metre	300	549	26	8:50	4	10	ESE	Overcast	E	4	Rough
1044	Metre	0	0	27	8:40	4	0	Circle	Overcast	SE	3	Moderate
1045	Metre	25	45	27	8:40	4	0	Circle	Overcast	SE	3	Moderate
1046	Metre	50	92	27	8:40	4	0	Circle	Overcast	SE	3	Moderate
1047	Metre	100	183	27	8:40	4	0	Circle	Overcast	SE	3	Moderate
1048	Metre	300	549	27	8:40	4	0	Circle	Overcast	SE	3	Moderate
				July								
1049	Metre	0	0	6	8:38	5	5	SW	Clear	NE	4	Choppy
1050	Metre	25	45	6	8:38	5	5	SW	Clear	NE	4	Choppy
1051	Metre	50	92	6	8:38	5	5	SW	Clear	NE	4	Choppy
1052	Metre	300	549	6	8:38	5	5	SW	Clear	NE	4	Choppy
1053	Metre	300	549	6	8:38	5	5	SW	Clear	NE	4	Choppy
1054	Metre	25	45	7	8:40	5	0	NW	Clear	NE	2	Moderate
1055	Metre	50	92	7	8:40	5	0	NW	Clear	NE	2	Moderate
1056	Metre	50	92	7	8:40	5	0	NW	Clear	NE	2	Moderate
1057	Metre	100	183	7	8:40	5	0	NW	Clear	NE	2	Moderate
1058	Metre	300	549	7	8:40	5	0	NW	Clear	NE	2	Moderate
1059	Metre	100	183	8	8:40	5	0	ESE	Clear	E	2	Calm
1060	Metre	200	366	8	8:40	5	0	ESE	Clear	E	2	Calm
1061	Metre	300	549	8	8:40	5	0	ESE	Clear	E	2	Calm
1062	Metre	300	549	8	8:40	5	0	ESE	Clear	E	2	Calm
1063	Metre	300	549	8	8:40	5	0	ESE	Clear	E	2	Calm
1064	Metre	100	183	9	9:09	4	32	E	Clear	SE	4	Swell
1065	Metre	200	366	9	9:09	4	32	E	Clear	SE	4	Swell
1066	Metre	300	549	9	9:09	4	32	E	Clear	SE	4	Swell
1067	Metre	300	549	9	9:09	4	32	E	Clear	SE	4	Swell
1068	Metre	300	549	9	9:09	4	32	E	Clear	SE	4	Swell
1069	Metre	50	92	10	8:40	4	50	W	Clear	S	2	Swell

INDIVIDUAL NETS AND DATA — *Continued*

Net No.	Type of Net	Depth		Date 1931	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				July		H	M					
1070	Metre	300	549	10	8:40AM	4	50	W	Clear	S	2	Swell
1071	Metre	300	549	10	8:40	4	50	W	Clear	S	2	Swell
1072	Metre	300	549	10	8:40	4	50	W	Clear	S	2	Swell
1073	Metre	300	549	10	8:40	4	50	W	Clear	S	2	Swell
1074	Metre	25	45	11	8:46	5	46	E	Clear	SE	3	Swell
1075	Metre	50	92	11	8:46	5	46	E	Clear	SE	3	Swell
1076	Metre	300	549	11	8:46	5	46	E	Clear	SE	3	Swell
1077	Metre	300	549	11	8:46	5	46	E	Clear	SE	3	Swell
1078	Metre	300	549	11	8:46	5	46	E	Clear	SE	3	Swell
1079	Metre	50	92	14	8:50	5	40	SW	Clear	S	2	Calm
1080	Metre	100	183	14	8:50	5	40	SW	Clear	S	2	Calm
1081	Metre	200	366	14	8:50	5	40	SW	Clear	S	2	Calm
1082	Metre	300	549	14	8:50	5	40	SW	Clear	S	2	Calm
1083	Metre	300	549	14	8:50	5	40	SW	Clear	S	2	Calm
1084	Metre	25	45	15	8:50	5	25	E to NE	Overcast	SW	1	Calm
1085	Metre	50	92	15	8:50	5	25	E to NE	Overcast	SW	1	Calm
1086	Metre	300	549	15	8:50	5	25	E to NE	Overcast	SW	1	Calm
1087	Metre	300	549	15	8:50	5	25	E to NE	Overcast	SW	1	Calm
1088	Metre	300	549	15	8:50	5	25	E to NE	Overcast	SW	1	Calm
1089	Metre	50	92	18	8:57	2	33	SW to E	Squally	W	4	Swell
1090	Metre	100	183	18	8:57	2	33	SW to E	Squally	W	4	Swell
1091	Metre	200	366	18	8:57	2	33	SW to E	Squally	W	4	Swell
1092	Metre	300	549	18	8:57	2	33	SW to E	Squally	W	4	Swell
1093	Metre	300	549	18	8:57	2	33	SW to E	Squally	W	4	Swell
1094	Metre	400	732	24	9:17	4	58	ESE	Clear	SW	1	Calm
1095	Metre	600	1097	24	9:17	4	58	ESE	Clear	SW	1	Calm
1096	Metre	700	1280	24	9:17	4	58	ESE	Clear	SW	1	Calm
1097	Metre	700	1280	25	9:17	4	58	ESE	Clear	SW	1	Calm
1098	Metre	900	1646	24	9:17	4	58	ESE	Clear	SW	1	Calm
1099	Metre	900	1646	24	9:17	4	58	ESE	Clear	SW	1	Calm
1100	Metre	1000	1829	24	9:17	4	58	ESE	Clear	SW	1	Calm
1101	Metre	400	732	25	9:30	4	10	S	Overcast	S	1	Calm
1102	Metre	500	914	25	9:30	4	10	S	Overcast	S	1	Calm
1103	Metre	600	1097	25	9:30	4	10	S	Overcast	S	1	Calm
1104	Metre	700	1280	25	9:30	4	10	S	Overcast	S	1	Calm
1105	Metre	800	1463	25	9:30	4	10	S	Overcast	S	1	Calm
1106	Metre	900	1646	25	9:30	4	10	S	Overcast	S	1	Calm
1107	Metre	400	732	27	9:30	4	0	SW	Overcast	SW	1	Calm
1108	Metre	500	914	27	9:30	4	0	SW	Overcast	SW	1	Calm
1109	Metre	600	1097	27	9:30	4	0	SW	Overcast	SW	1	Calm
1110	Metre	600	1097	27	9:30	4	0	SW	Overcast	SW	1	Calm
1111	Metre	800	1463	27	9:30	4	0	SW	Overcast	SW	1	Calm
1112	Metre	900	1646	27	9:30	4	0	SW	Overcast	SW	1	Calm
1113	Metre	400	732	29	9:34	4	11	ESE	Clear	S	1	Calm
1114	Metre	400	732	29	9:34	4	11	ESE	Clear	S	1	Calm
1115	Metre	500	914	29	9:34	4	11	ESE	Clear	S	1	Calm
1116	Metre	800	1463	29	9:34	4	11	ESE	Clear	S	1	Calm
1117	Metre	1000	1829	29	9:34	4	11	ESE	Clear	S	1	Calm
1118	Metre	1000	1829	29	9:34	4	11	ESE	Clear	S	1	Calm

INDIVIDUAL NETS AND DATA — *Continued*

Net No.	Type of Net	Depth		Date 1931	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Aug.		H	M					
1119	Metre	400	732	3	9:08AM	4	33	E	Overcast	NW	1	Moderate
1120	Metre	400	732	3	9:08	4	33	E	Overcast	NW	1	Moderate
1121	Metre	500	914	3	9:08	4	33	E	Overcast	NW	1	Moderate
1122	Metre	600	1097	3	9:08	4	33	E	Overcast	NW	1	Moderate
1123	Metre	700	1280	3	9:08	4	33	E	Overcast	NW	1	Moderate
1124	Metre	800	1463	3	9:08	4	33	E	Overcast	NW	1	Moderate
1125	Metre	400	732	4	9:24	4	6	SxW	Clear	NE	1	Calm
1126	Metre	400	732	4	9:24	4	6	SxW	Clear	NE	1	Calm
1127	Metre	900	1646	4	9:24	4	6	SxW	Clear	NE	1	Calm
1128	Metre	1000	1829	4	9:24	4	6	SxW	Clear	NE	1	Calm
1129	Metre	1000	1829	4	9:24	4	6	SxW	Clear	NE	1	Calm
1130	Metre	1000	1829	4	9:24	4	6	SxW	Clear	NE	1	Calm
1131	Metre	500	914	5	9:20	4	20	ESE	Clear	0	0	Calm
1132	Metre	600	1097	5	9:20	4	20	ESE	Clear	0	0	Calm
1133	Metre	700	1280	5	9:20	4	20	ESE	Clear	0	0	Calm
1134	Metre	800	1463	5	9:20	4	20	ESE	Clear	0	0	Calm
1135	Metre	900	1646	5	9:20	4	20	ESE	Clear	0	0	Calm
1136	Metre	1000	1829	5	9:20	4	20	ESE	Clear	0	0	Calm
1137	Metre	600	1097	6	8:55	4	5	SSW	Overcast	W	2	Moderate
1138	Metre	600	1097	6	8:55	4	4	SSW	Overcast	W	2	Moderate
1139	Metre	700	1280	6	8:55	4	5	SSW	Overcast	W	2	Moderate
1140	Metre	700	1280	6	8:55	4	5	SSW	Overcast	W	2	Moderate
1141	Metre	800	1463	6	8:55	4	5	SSW	Overcast	W	2	Moderate
1142	Metre	800	1463	6	8:55	4	5	SSW	Overcast	W	2	Moderate
1143	Metre	500	914	7	9:00	4	0	E to NE	Clear	NW	2	Moderate
1144	Metre	500	914	7	9:00	4	0	E to NE	Clear	NW	2	Moderate
1145	Metre	600	1097	7	9:00	4	0	E to NE	Clear	NW	2	Moderate
1146	Metre	600	1097	7	9:00	4	0	E to NE	Clear	NW	2	Moderate
1147	Metre	700	1280	7	9:00	4	0	E to NE	Clear	NW	2	Moderate
1148	Metre	700	1280	7	9:00	4	0	E to NE	Clear	NW	2	Moderate
1149	Metre	500	914	8	8:55	4	35	E	Overcast	0	0	Calm
1150	Metre	500	914	8	8:55	4	35	E	Overcast	0	0	Calm
1151	Metre	600	1097	8	8:55	4	35	E	Overcast	0	0	Calm
1152	Metre	600	1097	8	8:55	4	35	E	Overcast	0	0	Calm
1153	Metre	700	1280	8	8:55	4	35	E	Overcast	0	0	Calm
1154	Metre	700	1280	8	8:55	4	35	E	Overcast	0	0	Calm
1155	Metre	400	732	10	9:12	4	3	SW	Clear	W	3	Moderate
1156	Metre	500	914	10	9:12	4	3	SW	Clear	W	3	Moderate
1157	Metre	500	914	10	9:12	4	3	SW	Clear	W	3	Moderate
1158	Metre	600	1097	10	9:12	4	3	SW	Clear	W	3	Moderate
1159	Metre	700	1280	10	9:12	4	3	SW	Clear	W	3	Moderate
1160	Metre	800	1463	10	9:12	4	3	SW	Clear	W	3	Moderate
1161	Metre	500	914	11	9:15	4	25	SSW	Overcast	SW	2	Moderate
1162	Metre	800	1463	11	9:15	4	25	SSW	Overcast	SW	2	Moderate
1163	Metre	800	1463	11	9:15	4	25	SSW	Overcast	SW	2	Moderate
1164	Metre	800	1463	11	9:15	4	25	SSW	Overcast	SW	2	Moderate
1165	Metre	900	1646	11	9:15	4	25	SSW	Overcast	SW	2	Moderate
1166	Metre	900	1646	11	9:15	4	25	SSW	Overcast	SW	2	Moderate
1167	Metre	500	914	12	9:42	4	18	ESE	Overcast	SE	2	Swell
1168	Metre	600	1097	12	9:42	4	18	ESE	Overcast	SE	2	Swell

INDIVIDUAL NETS AND DATA — *Continued*

Net No.	Type of Net	Depth Fathoms	Depth Metres	Date 1931	Start of Haul	Duration of Haul H	Duration of Haul M	Direction of Haul	Weather	Wind Direction	Wind Force	Sea
				Aug.		H	M					
1169	Metre	700	1280	12	9:42AM	4	18	ESE	Overcast	SE	2	Swell
1170	Metre	800	1463	12	9:42	4	18	ESE	Overcast	SE	2	Swell
1171	Metre	900	1646	12	9:42	4	18	ESE	Overcast	SE	2	Swell
1172	Metre	1000	1829	12	9:42	4	18	ESE	Overcast	SE	2	Swell
1173	Metre	400	732	14	9:20	3	0	ESE	Overcast	NE	4	Rough
1174	Metre	500	914	14	9:20	3	0	ESE	Overcast	NE	4	Rough
1175	Metre	600	1097	14	9:20	3	0	ESE	Overcast	NE	4	Rough
1176	Metre	700	1280	14	9:20	3	0	ESE	Overcast	NE	4	Rough
1177	Metre	800	1463	14	9:20	3	0	ESE	Overcast	NE	4	Rough
1178	Metre	900	1646	14	9:20	3	0	ESE	Overcast	NE	4	Rough
1179	Metre	0	0	14	8:30PM		30	S and N	No moon	SE	2	Calm
1180	Metre	500	914	15	9:20AM	4	0	E to NE	Clear	E	1	Swell
1181	Metre	600	1097	15	9:20	4	0	E to NE	Clear	E	1	Swell
1182	Metre	700	1280	15	9:20	4	0	E to NE	Clear	E	1	Swell
1183	Metre	800	1463	15	9:20	4	0	E to NE	Clear	E	1	Swell
1184	Metre	800	1463	15	9:20	4	0	E to NE	Clear	E	1	Swell
1185	Metre	900	1646	15	9:20	4	0	E to NE	Clear	E	1	Swell
1186	Metre	0	0	16	8:00PM		40	S	No moon	SW	1	Calm
1187	Metre	400	732	16	9:43AM	3	57	WSW	Overcast	W	2	Swell
1188	Metre	500	914	16	9:43	3	57	WSW	Overcast	W	2	Swell
1189	Metre	700	1280	16	9:43	3	57	WSW	Overcast	W	2	Swell
1190	Metre	900	1646	16	9:43	3	57	WSW	Overcast	W	2	Swell
1191	Metre	1000	1829	16	9:43	3	57	WSW	Overcast	W	2	Swell
1192	Metre	1000	1829	16	9:43	3	57	WSW	Overcast	W	2	Swell
1193	Metre	500	914	17	9:45	4	15	E to NE	Overcast	N	2	Swell
1194	Metre	700	1280	17	9:45	4	15	E to NE	Overcast	N	2	Swell
1195	Metre	800	1463	17	9:45	4	15	E to NE	Overcast	N	2	Swell
1196	Metre	800	1463	17	9:45	4	15	E to NE	Overcast	N	2	Swell
1197	Metre	1000	1829	17	9:45	4	15	E to NE	Overcast	N	2	Swell
1198	Metre	1000	1829	17	9:45	4	15	E to NE	Overcast	N	2	Swell
1199	Metre	500	914	19	9:49	3	51	SE to E	Overcast	SW	1	Swell
1200	Metre	600	1097	19	9:49	3	51	SE to E	Overcast	SW	1	Swell
1201	Metre	800	1463	19	9:49	3	51	SE to E	Overcast	SW	1	Swell
1202	Metre	800	1463	19	9:49	3	51	SE to E	Overcast	SW	1	Swell
1203	Metre	900	1646	19	9:49	3	51	SE to E	Overcast	SW	1	Swell
1204	Metre	900	1646	19	9:49	3	51	SE to E	Overcast	SW	1	Swell
1205	Metre	700	1280	20	9:23	4	45	SW	Clear	SW	3	Swell
1206	Metre	800	1463	20	9:23	4	45	SW	Clear	SW	3	Swell
1207	Metre	900	1646	20	9:23	4	45	SW	Clear	SW	3	Swell
1208	Metre	900	1646	20	9:23	4	45	SW	Clear	SW	3	Swell
1209	Metre	1000	1829	20	9:23	4	45	SW	Clear	SW	3	Swell
1210	Metre	1000	1829	20	9:23	4	45	SW	Clear	SW	3	Swell
1211	Metre	300	549	21	10:55	1	40	E	Overcast	SW	4	Rough
1212	Metre	400	732	21	10:55	1	40	E	Overcast	SW	4	Rough
1213	Metre	900	1646	21	10:55	1	40	E	Overcast	SW	4	Rough
1214	Metre	1000	1829	21	10:55	1	40	E	Overcast	SW	4	Rough
1215	Metre	1000	1829	21	10:55	1	40	E	Overcast	SW	4	Rough
1216	Metre	1000	1829	21	10:55	1	40	E	Overcast	SW	4	Rough
1217	Metre	600	1097	24	9:40	3	56	SW	Overcast	SW	3	Swell
1218	Metre	700	1280	24	9:40	3	56	SW	Overcast	SW	3	Swell

INDIVIDUAL NETS AND DATA — *Continued*

Net No.	Type of Net	Depth Fathoms	Depth Metres	Date 1931	Start of Haul	Duration of Haul H	Duration of Haul M	Direction of Haul	Weather	Wind Direction	Wind Force	Sea
				Aug.								
1219	Metre	900	1646	24	9:40AM	3	56	SW	Overcast	SW	3	Swell
1220	Metre	1000	1829	24	9:40	3	56	SW	Overcast	SW	3	Swell
1221	Metre	1000	1829	24	9:40	3	56	SW	Overcast	SW	3	Swell
1222	Metre	1000	1829	24	9:40	3	56	SW	Overcast	SW	3	Swell
1223	Metre	0	0	24	8:20PM		30	Circle	Moonlight	SW	1	Calm
1224	4′Dr.	1500	2730	26	9:35AM		30	WSW	Clear	SW	1	Calm
1225	4′Dr.	1000	1829	26	1:20PM		30	WSW	Clear	SW	1	Calm
1226	Metre	300	549	27	9:16AM	4	19	WSW	Clear	SSW	1	Calm
1227	Metre	400	732	27	9:16	4	19	WSW	Clear	SSW	1	Calm
1228	Metre	500	914	27	9:16	4	19	WSW	Clear	SSW	1	Calm
1229	Metre	800	1463	27	9:16	4	19	WSW	Clear	SSW	1	Calm
1230	Metre	900	1646	27	9:16	4	19	WSW	Clear	SSW	1	Calm
1231	Metre	1000	1829	27	9:16	4	19	WSW	Clear	SSW	1	Calm
1232	Metre	0	0	27	8:00PM		20	S	Clear	SW	2	Calm
1233	4′Dr.	1000	1829	28	9:30AM		34	WSW	Clear	WSW	1	Calm
1234	4′Dr.	1000	1829	28	11:58		32	WSW	Clear	WSW	1	Calm
1235	Metre	500	914	29	9:27	4	23	SW	Overcast	W	1	Calm
1236	Metre	600	1097	29	9:27	4	23	SW	Overcast	W	1	Calm
1237	Metre	700	1280	29	9:27	4	23	SW	Overcast	W	1	Calm
1238	Metre	800	1463	29	9:27	4	23	SW	Overcast	W	1	Calm
1239	Metre	900	1646	29	9:27	4	23	SW	Overcast	W	1	Calm
1240	Metre	1000	1829	29	9:27	4	23	SW	Overcast	W	1	Calm
1241	Metre	500	914	31	9:33	4	2	E	Overcast	W	2	Swell
1242	Metre	600	1097	31	9:33	4	2	E	Overcast	W	2	Swell
1243	Metre	700	1280	31	9:33	4	2	E	Overcast	W	2	Swell
1244	Metre	800	1463	31	9:33	4	2	E	Overcast	W	2	Swell
1245	Metre	900	1646	31	9:33	4	2	E	Overcast	W	2	Swell
1246	Metre	1000	1829	31	9:33	4	2	E	Overcast	W	2	Swell
				Sept.								
1247	Metre	500	914	1	9:35	4	0	E to ENE	Overcast	NE	3	Swell
1248	Metre	600	1097	1	9:35	4	0	E to ENE	Overcast	NE	3	Swell
1249	Metre	700	1280	1	9:35	4	0	E to ENE	Overcast	NE	3	Swell
1250	Metre	800	1463	1	9:35	4	0	E to ENE	Overcast	NE	3	Swell
1251	Metre	900	1646	1	9:35	4	0	E to ENE	Overcast	NE	3	Swell
1252	Metre	1000	1829	1	9:35	4	0	E to ENE	Overcast	NE	3	Swell
1253	Metre	0	0	1	7:30PM		30	S	Clear	SW	2	Calm
1254	Metre	500	914	3	9:10AM	4	25	E	Clear	E	1	Swell
1255	Metre	600	1097	3	9:10	4	25	E	Clear	E	1	Swell
1256	Metre	700	1280	3	9:10	4	25	E	Clear	E	1	Swell
1257	Metre	800	1463	3	9:10	4	25	E	Clear	E	1	Swell
1258	Metre	900	1646	3	9:10	4	25	E	Clear	E	1	Swell
1259	Metre	1000	1829	3	9:10	4	25	E	Clear	E	1	Swell
1260	Metre	500	914	4	9:26	4	14	SE to E	Clear	S	3	Swell
1261	Metre	600	1097	4	9:26	4	14	SE to E	Clear	S	3	Swell
1262	Metre	700	1280	4	9:26	4	14	SE to E	Clear	S	3	Swell
1263	Metre	800	1463	4	9:26	4	14	SE to E	Clear	S	3	Swell
1264	Metre	900	1646	4	9:26	4	14	SE to E	Clear	S	3	Swell
1265	Metre	1000	1829	4	9:26	4	14	SE to E	Clear	S	3	Swell
1266	4′Dr.	1500	2730	5	8:59		36	SW	Clear	SW	2	Calm
1267	4′Dr.	1500	2730	5	11:38		35	SW	Clear	SW	2	Calm

INDIVIDUAL NETS AND DATA — *Continued*

Net No.	Type of Net	Depth		Date 1931	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Aug.		H	M					
1268	4′Dr.	1100	2002	5	2:09PM		31	SW	Overcast	SW	2	Calm
1269	Metre	0	0	4	8:00		20	SE	No moon	SW	2	Calm
1270	Metre	500	914	7	9:31AM	4	29	SW	Clear	SW	3	Moderate
1271	Metre	600	1097	7	9:31	4	29	SW	Clear	SW	3	Moderate
1272	Metre	700	1280	7	9:31	4	29	SW	Clear	SW	3	Moderate
1273	Metre	800	1463	7	9:31	4	29	SW	Clear	SW	3	Moderate
1274	Metre	900	1646	7	9:31	4	29	SW	Clear	SW	3	Moderate
1275	Metre	1000	1829	7	9:31	4	29	SW	Clear	SW	3	Moderate
1276	Metre	500	914	9	9:26	4	34	E to NE	Overcast	NW	2	Swell
1277	Metre	600	1097	9	9:26	4	34	E to NE	Overcast	NW	2	Swell
1278	Metre	700	1280	9	9:26	4	34	E to NE	Overcast	NW	2	Swell
1279	Metre	800	1463	9	9:26	4	34	E to NE	Overcast	NW	2	Swell
1280	Metre	900	1646	9	9:26	4	34	E to NE	Overcast	NW	2	Swell
1281	Metre	1000	1829	9	9:26	4	34	E to NE	Overcast	NW	2	Swell
1282	Metre	500	914	10	9:30	4	5	ESE	Clear	N	1	Calm
1283	Metre	600	1097	10	9:30	4	5	ESE	Clear	N	1	Calm
1284	Metre	700	1280	10	9:30	4	5	ESE	Clear	N	1	Calm
1285	Metre	800	1463	10	9:30	4	5	ESE	Clear	N	1	Calm
1286	Metre	900	1646	10	9:30	4	5	ESE	Clear	N	1	Calm
1287	Metre	1000	1829	10	9:30	4	5	ESE	Clear	N	1	Calm
1288	4′Dr.	2000	3640	11	12:54PM		36	NE	Clear	NE	3	Swell
1289	{Wire {Metre	300	549	11	3:15		30	N	Clear	NE	3	Swell
				Sept.		H	M					
1290	Metre	500	914	12	9:30AM	4	40	ESE	Clear	0	0	Calm
1291	Metre	600	1097	12	9:30	4	40	ESE	Clear	0	0	Calm
1292	Metre	700	1280	12	9:30	4	40	ESE	Clear	0	0	Calm
1293	Metre	800	1463	12	9:30	4	40	ESE	Clear	0	0	Calm
1294	Metre	900	1646	12	9:30	4	40	ESE	Clear	0	0	Calm
1295	Metre	1000	1829	12	9:30	4	40	ESE	Clear	0	0	Calm
1296	Metre	600	1097	14	9:48	4	17	ESE	Overcast	E	2	Swell
1297	Metre	700	1280	14	9:48	4	17	ESE	Overcast	E	2	Swell
1298	Metre	800	1463	14	9:48	4	17	ESE	Overcast	E	2	Swell
1299	Metre	900	1646	14	9:48	4	17	ESE	Overcast	E	2	Swell
1300	Metre	1000	1829	14	9:48	4	17	ESE	Overcast	E	2	Swell
1301	Metre	50	92	15	8:56	5	24	SW	Overcast	SE	3	Swell
1302	Metre	100	183	15	8:56	5	24	SW	Overcast	SE	3	Swell
1303	Metre	200	366	15	8:56	5	24	SW	Overcast	SE	3	Swell
1304	Metre	400	732	15	8:56	5	24	SW	Overcast	SE	3	Swell
1305	Metre	500	914	15	8:56	5	24	SW	Overcast	SE	3	Swell
1306	Metre	25	45	16	8:56	5	34	E	Clear	SE	1	Calm
1307	Metre	25	45	16	8:56	5	34	E	Clear	SE	1	Calm
1308	Metre	100	183	16	8:56	5	34	E	Clear	SE	1	Calm
1309	Metre	100	183	16	8:56	5	34	E	Clear	SE	1	Calm
1310	Metre	300	549	16	8:56	5	34	E	Clear	SE	1	Calm
1311	Metre	300	549	16	8:56	5	34	E	Clear	SE	1	Calm
1312	Metre	400	732	16	8:56	5	34	E	Clear	SE	1	Calm
1313	Metre	500	914	17	9:19	4	41	SE to NE	Clear	E	1	Calm
1314	Metre	600	1097	17	9:19	4	41	SE to NE	Clear	E	1	Calm
1315	Metre	700	1280	17	9:19	4	41	SE to NE	Clear	E	1	Calm

INDIVIDUAL NETS AND DATA — *Continued*

Net No.	Type of Net	Depth		Date 1931	Start of Haul	Duration of Haul		Direction of Haul	Weather	Wind		Sea
		Fathoms	Metres							Direction	Force	
				Aug.		H	M					
1316	Metre	800	1463	17	9:19AM	4	41	SE to NE	Clear	E	1	Calm
1317	Metre	900	1646	17	9:19	4	41	SE to NE	Clear	E	1	Calm
1318	Metre	1000	1829	17	9:19	4	41	SE to NE	Clear	E	1	Calm
1319	Metre	25	45	18	12:50PM	2	10	NE	Clear	E	2	Calm
1320	Metre	25	45	18	12:50	2	10	NE	Clear	E	2	Calm
1321	Metre	50	92	18	12:50	2	10	NE	Clear	E	2	Calm
1322	Metre	300	549	18	12:50	2	10	NE	Clear	E	2	Calm
1323	Metre	300	549	18	12:50	2	10	NE	Clear	E	2	Calm
1324	Metre	400	732	18	12:50	2	10	NE	Clear	E	2	Calm
1325	Metre	500	914	19	10:18AM	4	42	NExE	Overcast	W	3	Rough
1326	Metre	600	1097	19	10:18	4	42	NExE	Overcast	W	3	Rough
1327	Metre	700	1280	19	10:18	4	42	NExE	Overcast	W	3	Rough
1328	Metre	800	1463	19	10:18	4	42	NExE	Overcast	W	3	Rough
1329	Metre	900	1646	19	10:18	4	42	NExE	Overcast	W	3	Rough
1330	Metre	1000	1829	19	10:18	4	42	NExE	Overcast	W	3	Rough
				Oct.								
1331	Metre	500	914	28	9:22	4	42	SW	Clear	N	4	Swell
1332	Metre	600	1097	28	9:22	4	42	SW	Clear	N	4	Swell
1333	Metre	800	1463	28	9:22	4	42	SW	Clear	N	4	Swell
1334	Metre	900	1646	28	9:22	4	42	SW	Clear	N	4	Swell
1335	Metre	1000	1829	28	9:22	4	42	SW	Clear	N	4	Swell
1336	Metre	500	914	29	9:27	4	35	SxW	Overcast	S	3	Choppy
1337	Metre	600	1097	29	9:27	4	35	SxW	Overcast	S	3	Choppy
1338	Metre	700	1280	29	9:27	4	35	SxW	Overcast	S	3	Choppy
1339	Metre	700	1280	29	9:27	4	35	SxW	Overcast	S	3	Choppy
1340	Metre	800	1463	29	9:27	4	35	SxW	Overcast	S	3	Choppy
1341	Metre	900	1646	29	9:27	4	35	SxW	Overcast	S	3	Choppy
1342	Metre	1000	1829	29	9:27	4	35	SxW	Overcast	S	3	Choppy
				Nov.		H	M					
1343	Metre	0	0	2	7:30PM		20	S	No moon	S	2	Moderate
1344	Metre	0	0	3	7:30		20	N	Overcast	SW	3	Rough
1345	Metre	0	0	12	7:30		30	S	No moon	0	0	Calm
1346	Metre	0	0	12	8:00		30	N	No moon	0	0	Calm
1347	Metre	0	0	13	7:30		30	S	Moonlight	0	0	Calm
1348	Metre	0	0	13	8:00		30	N	Moonlight	0	0	Calm
1349	Metre	0	0	15	7:30		30	S	Moonlight	0	0	Calm
1350	Metre	0	0	17	3:30AM	1	0	S	No moon	S	2	Calm

New York Zoological Society

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NINETEEN NEW SPECIES AND FOUR POST-LARVAL DEEP-SEA FISH

By William Beebe

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NINETEEN NEW SPECIES AND FOUR POST-LARVAL DEEP-SEA FISH*

By WILLIAM BEEBE

(Figs. 8-31 incl.)

This is the first installment of descriptions of new forms of fish taken on the Bermuda Oceanographic Expeditions of the Department of Tropical Research of the New York Zoological Society. They were all taken within the eight-mile circle whose center is at 32° 12′ North Latitude and 64° 36′ West Longitude, nine and one quarter miles south-southeast of Nonsuch Island, Bermuda.

LIST OF SPECIES

**Contribution, New York Zoological Society, Department of Tropical Research, No. 367.*

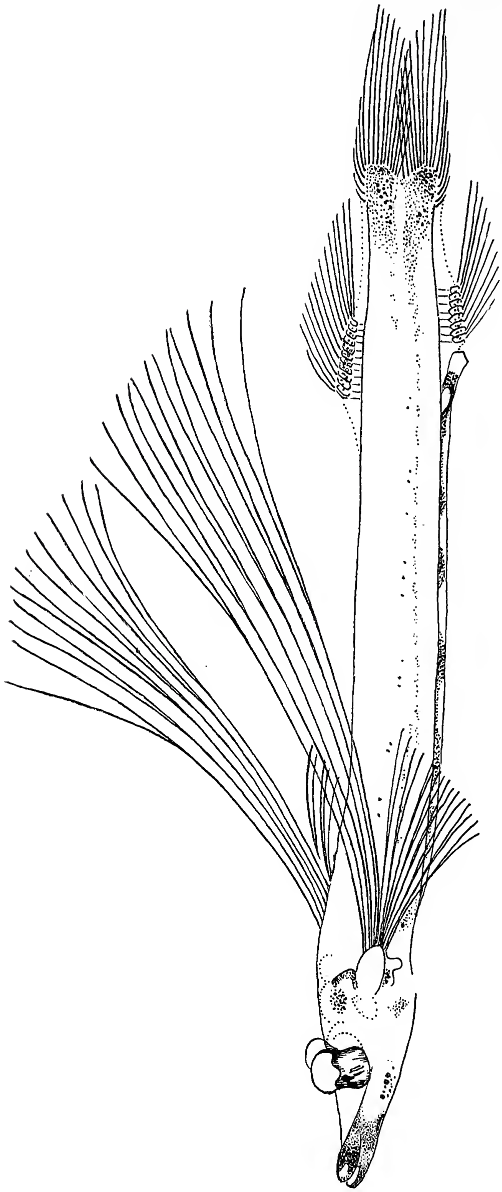


Fig. 8. *Dolichopteryx binocularis* sp. nov.

Dolichopteryx binocularis sp. nov.

Type: No. 21,867, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1125; *August* 4, 1931; 14 *miles southeast of Nonsuch, Bermuda;* 400 *fathoms; standard length* 85 *mm.*

Field Characters: An elongate, telescope-eyed fish, with very small mouth, exceedingly slender and elongate pectoral rays; scaleless except on lateral line, white and transparent above, with considerable dark pigment below: ventrals and vertical fins far aft on the body.

Measurements and Counts: Total length 101 mm.; standard length 85 mm.; depth 5 (in length 17); head 17 (in length 5); eye diameter 3.1 (in head 5.5); snout 7.1 (in head 2.4); mouth horizontal; eyes slanted 10° forward from the vertical; pectoral $6 + 8 = 14$; pectoral length 55 mm.; ventral $3 + 6 = 9$; ventral length 15; dorsal 15; anal 11; caudal XIII — 9 — 9 — XIV; caudal length 16 mm.

General Description: The fish as a whole appears as transparent white, with dark muzzle, five large, ventral blotches, and a midline of dark chromatophores.

The upper lip is white, the jaws solidly dusky, thinning into individual, black, round chromatophores back almost to the eyes; this pigment is close over the bone of the jaws, far beneath the outer, white, transparent skin; directly below the eyes are fourteen large, purplish, dendritic chromatophores, six in a straight row, the others in a bow shape below; on the side of the midbrain and back of the hind brain are solid masses of almost fused, black chromatophores; a large, triangular patch of many, very small ones over the lower angle of the gill arches; another large patch of disconnected ones directly over the heart which lies just below the pectorals; on the ventral surface are five dense patches of black showing purple glints; the fourth merges with the fifth far back beneath the ventrals; along the midline of the body a single row of iridescent or black chromatophores; these are arranged into successive groups, the more anterior of three to five chromatophores; from the midbody back the groups increase in number of components—five to ten—each group forming a short, oblique line, at a slight downward angle; midway between this line and the back is a second line of a very few, widely spread, large chromatophores, twenty-two altogether, quite irregular as regards spacing, two together or singly; from halfway between the end of the dorsal and the caudal the parallel-sided peduncle is thickly peppered with large and small, sepa-

rate, dendritic chromatophores, there being a clear space along the midline.

The body of the fish is elongate, with very little change in calibre throughout, the dorsal and ventral surfaces nearly parallel, the head narrows slowly into a broad, rounded muzzle, the eyes projecting well above the profile. The eyes rest in a great depression of the head, the upper part being covered with perfectly transparent tissue; the nostrils are round, close together, and about four-fifths the way to the snout from the eye; the eyes are very large, once and a half as high as wide, the stalk thick, short, dark, the summits clear, swollen and rounded; they are placed very close alongside each other, and slant forward 10° from the vertical; the eyeballs are overlaid on the front and outer side with longitudinal, prismatic, spicule scales, giving off blue, green and bronze reflections. On the outside the black of the eyeball extends upward in a rounded bay, which carries a large photophore, opening obliquely down and back in a silvery trough. The base of the eye-ball rests in a shallow saucer of silver spicules.

The mouth is very small, horizontal; the teeth are very indistinct in the uncleared specimen.

The dorsal fin arises high above the surface of the body, from a framework supporting an oval muscle and a tall baseost for each ray; forward the free skin stretches for a considerable distance, and posteriorly the high, free, transparent skin connects with the supra-caudal spines; the anal is similar in origin and the muscles of each fin have a scattering of black chromatophores along their sides.

The pectoral fins show a large, fleshy, basal pad, with a sharply oblique posterior rim, from which arise fourteen rays; the upper six are, in the fresh fish, directed straight back or slightly upward, and in this individual new-caught fish the first and sixth left rays and the first and third right rays were bent but still showed full length. They split into two about half-way of their length, and reached to half-way down the anal, or 55 mm. The lower eight were directed obliquely downward, showing a distinct break between the two, and were about equal in length, the largest being only 4.3 mm or one-fourteenth of the upper rays. The ventral rays reached the caudal and measured 15 mm.

The epidermis along the ventral surface from the gills to the anus is loose, well away from the body, suspended by numerous thread-like supports, carrying an opaque band of luminous tissue. The eye-light

is pale white; the ventral organ gleams only with the faintest sheen in the new caught specimen.

Dyed and Cleared: In the dyed and cleared specimen structures become visible which are unsuspected in the fresh or preserved fish. The most unexpected is a row of 48 lateral line scales extending from the opercle to the caudal. The first, just above the base of the dorsal pectoral rays, is a well-ossified, thick, half circle, opening backward. The next 26 are very small, thin, slightly ossified and irregular, some almost straight, others three-fourths of a circle. The 27th scale occurs at 18.6 mm. in front of the dorsal. From here on the scales increase in size and thickness, and become circular. At the 40th, just over the ventral fins, they reach their largest size, the diameter keeping even for the succeeding scales to the last at the very base of the caudal. These are .86 mm. in outside, vertical diameter with a central oval opening .5 mm. in length. From the 40th on, the posterior rim of the central opening shows a slight thickening of osseous tissue, which increases and concentrates toward the center until, in the 51st, a slight projection is visible. In the last five this extends clear across the central hole as a knob-shaped projection, and a low spine develops on the outside.

Anteriorly the scales are five or six of their diameters apart, but they gradually approach until posteriorly the edges slightly overlap. They are placed equidistantly between the row of isolated chromatophores, and the inferior, dense line. And now we see that each curve, or oblique row marks an individual scale, this being true even to the very first. The clear midline space in the pigmented peduncle is now explained, for it is quite filled up with the lateral line scales.

There is a second, incomplete row of scales, beginning between the 40th and 41st, and extending to the caudal. These are placed close beneath the oblique lines of chromatophores, alternate with the upper row, and are much smaller, almost round and solid. These round scales are smaller anteriorly and increase slightly in size backward. There is a short row of 5 scales, similar to these, above the line of scattered chromatophores extending a short distance along the sides from the opercles. All the scales are very delicate and deciduous, a few falling off at each change of fluid in the clearing process.

There is a row of about thirty, very small, close set, incurved teeth in the lower jaw. In the upper there are four to five rows of teeth. Externally, on the cleared, outer surface of the lips and jaw

the bases of these can be distinguished as separately ossified, mosaic-like, irregularly arranged crescents or kidney-shaped bony plates. Within the jaw each of these gives rise to a long recurved tooth, all lying flat in a solid mass against the roof of the jaw.

Of the eleven anal rays, only eight have ossified baseosts, the two anterior and the posterior ray lacking a bony support.

The fifteen dorsals show twelve baseosts, the anterior and posterior rays lacking them. The 2nd and 3rd show a single, high, thickened, anteriorly directed bone. The 1st ray is very short and the two lateral bases are not joined, standing erect as two short, curved, erect spines.

In the cleared tissue the nine ventrals are seen to be divided sharply into two divisions, six lower, very fine rays, close together, and three superior rays, placed farther apart and more than twice as stout as the others.

The luminous, ventral band of tissue along the free epidermis is now seen to have a large number of very small tubercles.

Discussion: In "Discovery Reports" Volume II, p. 271, Norman has considered the Vailliant's and Brauer's specimens, and the two taken on the *Discovery* as all belonging to one species—*longipes*. This can probably be decided with certainty only from cleared and stained specimens. The present individual is, in many ways, closest to the Discovery specimens, but is set apart by several characters, two of which will serve for specific distinction. The depth to the length is 17 instead of 12 and the pectoral fins are set apart into two divisions, the upper six of great length, reaching to the mid-anal, and the lower eight only one-fourteenth as long.

Chirostomias lucidimanus sp. nov.

Type: No. 22,200, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1157; *August* 10, 1931; 10 *miles south of Nonsuch, Bermuda;* 500 *fathoms; standard length* 225 *mm.*

Field Characters: A fusiform black fish with short, thick barbel, bearing a tri-lobed bulb, with various tentacles and beaded projections, the anterior being a group of five, 3/5 as long as the whole stem; pectorals six, threadlike, frayed out into numerous, fine, luminous tendrils; dorsal 16, anal 22.

Measurements and Counts: Total length 235 mm.; standard length 225 mm.; depth 36 (in length 6.2); head 37 (in length 6); eye 6.4 (in head 5.8); snout 10.7 (in head 3.45); pectoral 6; pectoral length 83; ventrals 7; ventral length 17; dorsal 16; anal 22; caudal length 10; barbel stem 25; anterior terminal filaments 15.

General Description: Dorsal and ventral profiles almost parallel, sloping rather sharply toward the rounded snout, and very gradually toward the abruptly narrowed and short peduncle; adipose fin well developed. In one-half of the upper jaw are two large anterior canines, the second much the larger; behind the second canine and outside it a series of five medium-sized teeth begins, wide-spaced and ending halfway down the jaw, all outside the dental line; just behind and in a line with the second canine, the normal jaw teeth, all evenly-sized, extend to the gape, ten in number. The arrangement and size of the mandibular teeth are identical with those in the upper jaw. Every tooth has its small understudy companion, waiting to take its place when need arises. The illicium bulb is blue-black, elongate and somewhat compressed. The terminal part projects as two large tubular divisions, each tipped with a pair of sharp, tooth-like structures opening toward one another. The uppermost has a few very short tubercles at the tip, but the lower one is tipped with a long, beaded, luminous tentacle, while from the ventral side, five long (7.1 mm.) tentacles spring from a single base. These under ultra-violet light give out a pinkish glow. The dorsal surface of the bulb shows a number of isolated spots of luminous tissue which consolidate into a thick, luminous, white comb, smooth and rounded, with a slender, distal filament. The luminous tissue (white glow on this area) dies out on the surface of the mid-bulb in an ever-thinning mass of scattered spots and dots.

There is at least a single muscle at the tip of the bulb which has the power of separating widely the two terminal structures, the four teeth-like structures showing up strongly through the translucent pink luminous tissue

Lateral line of photophores: O-V 23, V-A 19 (7 of these above anal); ventral line: I-P 9, P-V 25, V-A 19 (6 of these above anal), A-C 10.

Comparison: I have taken four specimens of this form in the limited area in which I am trawling, measuring from 38.6 to 225 mm. standard length. They approach, in many particulars, Regan's *pliop-*

terus, but the eye is smaller in *lucidimanus* being only three-fifths as long as the snout, and 5.8 instead of 4 to 5 in the head; the dorsal is 16 instead of 18 to 20 and the ventrals are a full fifth nearer the caudal than to the eye.

The details of the bulb and its distal tentacles differ in the same degree in my small as in my large individuals and the same applies to the pectoral fins. As a contrast I have one small specimen of 35 mm. which is typically *pliopterus* in all its characters.

The only other recorded specimens are seven taken by the Dana. These were secured at depths of approximately 40 to 273 fathoms, and measure from 33 to 115 mm. standard length.

Eustomias schiffi sp. nov.

Type: *No.* 15,653, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 646; *May* 29, 1930; *six miles south of Nonsuch Island, Bermuda;* 600 *fathoms; standard length* 115 *mm.*

Measurements and Counts: Standard length 115 mm.; depth 9 (in length 12.7); head 14.3 (in length 8); eye 2.7 (in head 5.3); snout 5.4 (in head 2.6); pectoral 2; pectoral length 16.4; ventral 7; ventral length 18; dorsal 23; anal 37; caudal VII + 26 + V; caudal length 10.7; barbel length 57 (in length 2).

General Description: The body is slender and elongate; the back is parallel with the ventral outline, sloping gently posteriorly; with the upper jaw retracted the anterior profile is deeply indented, there is a very steep curve in front of the eye, then a thick dermal wrinkle and a straight line to the snout; the head is short, shallow and flattened ventrally; the snout is elongate, retracted, with a deep roll of skin rolled up from eye to eye around the mid-snout, formed by the posterior edge of the premaxillaries; the eyes show considerable projection above the head profile; nostrils are close together, rather large, close to the antero-superior margin of the eye; the mouth is large and slightly oblique; the maxillaries extend well behind the eye.

Teeth: There are 14 teeth in each premaxillary, a larger and a shorter pair close together at the very tip of the snout, then a space, then a large pair of fangs, and the rest smaller and irregular. The maxillary has 18 very small, oblique denticles. In the mandible there is a median pair of small teeth at the sypmphysis, and a very large pair

at the antero-exterior angle of the front of the jaw, followed by 15 more teeth, four of which are moderately large, making 17 altogether on each side of the lower jaw.

Skin: Appears black to the eye, rich dark brown under the lens, covered with an infinite number of minute photophores in areas arranged more or less in regular bands or patches. There is the usual arrangement of larger light organs on the head and body; a round, suborbital cheek-light is .57 mm. in diameter, showing a silvery white light. The two rows of body lights are dark purplish violet. The photophores show the following counts:

Ventral I-P 8, P-V 32, V-A 15, A-C 18; lateral P-V 34, V-15.

Fins: The vertical fins are typical of the Eustomiads, concentrated toward the caudal end, the three forming a unified, and the only, means of propulsion; the pectorals are non-natatory and non-luminous, wholly tactile in function; each is reduced to two elongated rays, longer than the head, with a transparent vein down each ray, like a slender leaf; the ventrals are one and a third times the length of the head, and similar to the pectorals except that all are delicately bound together by webbing; the longest rays reach well beyond the beginning of the anal fin; the caudal has two unequal lobes, the lower of which is the longer; there are 26 functional caudal rays.

Barbel: This elaborate organ is half as long as the standard length of the body. The stem is very long and slender with a thin core rather thickly speckled with small, black dendritic chromatophores, and two lines of dull red—not veins—extending down its entire length. Antero-posteriorly the stem expands into a gradually widening transparent area, then into a retort-shaped bulb, pale brown on the anterior or lower surface. This color changes abruptly into brilliant peacock blue on the body of the retort, and this in turn into turquoise back along the neck. This neck of the retort is drawn out into a transparent, slowly narrowing process, filled with a few oblong luminous granules. This process gives off about fifteen long thread-like tentacles, each with a central, single line of granules. The tentacles are transparent, the granules of the palest, blue green. Just before the beginning of the neck of the retort, a thick finger-like tentacle arises from the upper or posterior side, ending abruptly, with no appendages. From each side of this part of the retort arise branched processes like the larger terminal one, one large one on the left side, three lesser ones on the right,

these breaking up in turn into three to eight elongate, transparent threads.

Scattered along the transparent sheath of the long barbel stem are oval bodies, lying against the outer surface and all faintly ribbed, indicated by a slightly greater density. At the very base is a swollen, elongated scarlet body lying close to the core.

General Discussion: In Regan's Key of *Eustomias* (p. 75)* he lists *dubius* as "One bulb bearing two minute filaments", including in this Parr's type which terminates in a mutilated or regenerated flattened, irregular fan of tissue. Next on the list is *polyaster* with the definition "A small bulb proximal to main one, which bears a branched terminal appendage with bulb-like bodies in the stem."

The general heading of these two species "Pectoral of two rays," and "Barbel with a bulb divided by a distal notch into two equal lobes, the larger tapering" admits the present specimen, while the proportions bring it close to *dubius* and the barbel to *polyaster*. It is, however, very obviously distinct.

Eustomias schiffi differs from *dubius* in having 32 ventral P-V photophores, not 34 — 36; the barbel is ½ the length of the fish, not 2/7 to 1/3; and the barbel filaments are wholly different. From *polyaster* it differs in possessing only a single bulb instead of two to four, in the smaller number of ventral P-V photophores, and in having 14 instead of 11 teeth in the premaxillary.

I have named this species in memory of Mortimer Schiff whose interest in the work of this expedition was very deep and sincere.

Lamprotoxus angulifer sp. nov.

Type: *No.* 21,667, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1108; *July* 27, 1931; 15 *miles southeast of Nonsuch;* 500 *fathoms; standard length* 145 *mm.*

Field Characters: An elongate, black melanostomid, with long anterior fangs, elongate barbel, a long luminous line extending down the sides with a short, downward, anterior hook; a second labial line from snout half-way down jaw, and a curved luminous line from eye around to mid-jaw. Pectorals five, three with luminous tissue.

The Danish "Dana" Expedition, Report No. 6, 1930.

Measurements and Counts: Standard length 145; total 155; depth 18 (in length 8); head 25 (in length 5.8); eye 2.8 (in head 9), snout 4.3 (in head 5.8); mandible 22 (in head 1.1, in length 6.6); pectoral 5, pectoral length 7; ventral 7, ventral length 14.5; dorsal 21; anal 19 rays.

General Description: Body elongate, with rather straight, parallel contours, dorsal and anal fins far posterior, quite dominating and with much of the function of the caudal; head moderate with the usual enormous opercular opening of this group; a somewhat short, swollen snout, once and a half the diameter of the rather small eye; nostrils round, close together, nearer eye than snout; mouth large, jaws straight.

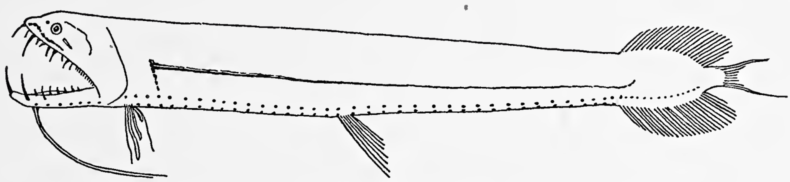


Fig. 9. *Lamprotoxus angulifer* sp. nov.

Teeth: At the tip of the premaxillary is a very long, strong pair of fangs, and following there is a line of five pairs of sharp teeth lying outside the dental ridge, the 1st and 5th twice as long as the others; along the ridge are ten teeth in each half jaw, the anterior pair very long. In front of the mandible is the longest pair of teeth to be found in the jaws. At wide, equal distances along the jaw are two more pairs of fangs, large and curved, all three pairs lying well outside the dental line. Inside of these are about fifteen teeth of varying size, scattered along each mandibular ramus. There are three pairs of small teeth on the palatines.

Skin: The skin is smooth, blackish brown, with the usual segments marked off by lines of black pigment.

The barbel is broken off at 13 mm. from the base, but was probably simple and of considerably greater length, as in *Lamprotoxus flagellibarba.*

Photophores: There is a moderate sized, narrowly pyriform, silvery cheek light behind the eye, 1.4 mm. in length, in a frame 2.4 mm.

long. The fish is covered from snout to tail with hundreds of very minute photophores pale pinkish in color, but like the larger ones in everything but size and regularity of position.

The lateral row of body photophores shows the following arrangement, O-V 16, V-A 22, A-C 12; the ventral ones I-P 7, P-V 17, V-A 19.

The lights on the branchiostegals are pale violet, those along the body deeper purple, with very large, concave gold caps.

Luminous Tissue: There is a very definite pattern of white, luminous tissue along the sides of the body in the shape of a long-handled, angled crook, the anterior part of which is formed by a solid line such as I have found in *L. flagellibarba*. The crook extends straight downward close to the posterior edge of the gill opening, breaking up into several, elongate spots toward the end. The handle extends down the midline, halfway the length of the anal. It consists of two divisions, a ventral, solid line for much of the distance, and a dorsal line, very close to it of small separate spots. The line becomes single at the level of the tenth lateral photophore beyond the ventral fin.

Besides this there is an almost solid line of luminous tissue from the tip of the snout down each side of the upper lip to a level with the middle of the eye, and a third, very thin, wavering but solid line arising back of the eye and curving back and down toward the anterior end of the maxillary denticles.

Fins: The vertical fins are not very high, and are concentrated at the far posterior end of the body. All are covered thickly with the dark body pigment. The dorsal and anal originate at the same vertical but, although the dorsal contains the greater number of rays, twenty-one, the anal is considerably the longer. Measured from the midline base of the caudal, the dorsal ends at a distance of 5 mm. and the anal of 9 mm. The caudal is small, deeply crescent-shaped, with the inferior lobe much prolonged.

The pectorals are placed very low and close together. They are short, wholly without natatory power, but greatly specialized as luminous organs. There are five rays, the 1st and 5th very long, thread-like and brown in color. The 2nd, 3rd and 4th show the same thin line of brown pigment but extending along their full length is a thick column of white, opaque, luminous tissue. The 1st, 2nd and 5th rays are equally long, 7 mm., but the remaining two are shorter.

The ventrals are pigmented, well-developed, consisting of seven rays, which however, are too filiform to be of much use in steering or progression.

A second specimen of *Lamprotoxus angulifer* was taken three weeks after the first; No. 22,483; Net 1187; August 17, 1931; twelve miles southeast of Nonsuch; 400 fathoms.

This fish is one-fourth as long as the first, but shows all the characteristics of the genus and species; standard length 33.6 mm.; head 5.7 (in length 5.9).

The fish was badly mutilated, the entire body cavity being torn open, but only the ventral photophores were injured beyond count; the fangs, the pectorals with their rays thickened with luminous tissue, the position and character of the ventrals, the long lateral line of luminous tissue along the side of the body, bent sharply downward close to the gill-opening, all confirm the validity of the species.

Discussion: This fish is close to *Grammatostomias dentatus* especially in number of pectoral rays, but differs decidedly in the much smaller eye relative to the head—5 in *Grammatosomias,* 9 in *L. angulifer* —and in the presence of the cephalic and somatic luminous patterns. This elaborate, lateral, light tissue is less developed in extent and wholly different in pattern, but directly related to that in *L. flagellibarba.*

Leptostomias bermudensis sp. nov.

Type: *No.* 20,826; *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1015; *June* 15, 1931; 7½ *miles southeast of Nonsuch;* 500 *fathoms; standard length* 285 *mm.*

Measurements and Counts: Total length 297 mm.; standard length 285 mm.; depth 18 (in length 15.8); head 26 (in length 11.0); eye 4.3 (in head 6.0); snout 11.4 (in head 2.2); maxillary 15 (in head 1.7, in length 19.0); pectoral rays 12; pectoral length 12; ventral rays 7; ventral length 33; dorsal rays 20; anal rays 25; barbel length 200 (72% of length).

Teeth: In each half of the upper jaw are 5 teeth, the second largest, with several small subsidiary teeth. On the maxillary are 4 to 6 denticles, followed by a long line of very minute denticles. The dentition of the lower jaw, except for the absence of denticles, is similar to that of the upper.

Photophores: The photophores of the lateral series are arranged as follows: O-V 48, V-A 22; those of the ventral series: I-P 10, P-V 48, V-A 21, A-O 12.

Barbel: The stem is unbranched except at the very base of the bulb. It is black for a considerable portion of the proximal portion, then this pales and grays, and changes into brilliant lilac with a dark core running through it. The bulb is abruptly bright, clear, picric yellow. The filaments are translucent white with a scattering of black specks.

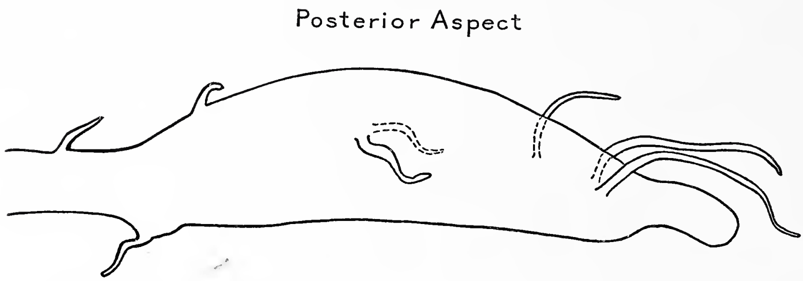


Fig. 10. *Leptostomias bermudensis* sp. nov. Barbel viewed from the left side.

The bulb arises abruptly from the stem, the lilac and the dark center ceasing at once. The bulb is slender, slightly curved, tapers gently from its center, and resembles in shape a diminutive cucumber. It narrows abruptly near the distal end, forming an elongate, rounded, terminal stem.

There are three short, thin median filaments given off, one from the back of the stem, and the other two from the proximal part of the bulb. Half-way down the bulb a pair of larger filaments arises, one from each side. Still farther a single one appears from the right side and, at the point of narrowing into the terminal stem, arises a final pair of filaments, the longest of all, about 4 mm. in length.

Discussion: This species closely resembles *L. macropogon* Norman and *L. longibarba,* Regan and Trewavas, but it may be distinguished from both by the structure of the bulb of the barbel and by the presence of 48 P-V photophores in both the lateral and ventral series.

Photichthys nonsuchae sp. nov.

Type: No. 9973, Bermuda Oceanographic Expedition, New York Zoological Society; Net 63; May 3, 1929; 7 miles south-south-west of Nonsuch; 600 fathoms; Standard length 89 mm.

Measurements and Counts: Standard length 89; depth 18 (in length 4.9); head 26.5 (in length 3.3); eye 8 (in head 3.3); inter-orbital 4.5 (in head 5.9); snout 6.5 (in head 4.1); mandible 18.5 (in head 1.4, in length 4.8); least caudal depth 7.5 (in length 11.9); pectoral 9; ventral 7; dorsal 12; anal 14; gill-rakers 5 + 13 (all, except 4 moderately long ones at the angle of the arch, are very short).

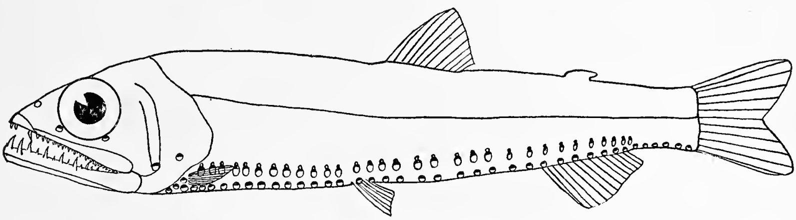


Fig. 11. *Photichthys nonsuchae* sp. nov.

Teeth: There are three pairs of teeth in the premaxillary: two small teeth at each side of the tip followed after an interval by a moderately strong canine. On the maxillary is a single series of about 16 pairs of small teeth with minute denticles between. In the mandible are ten pairs of large teeth with one or more smaller teeth usually present in each of the interspaces. The rudiments of a pair of teeth are barely distinguishable on the vomer. On the palatine are eleven pairs of curved teeth in a single series, decreasing in size posteriorly.

Photophores: There are 14 pairs of branchiostegal photophores. The lateral series of the trunk photophores shows the following arrangement, O-V 12, V- end of series 19. The last lateral photophore is located above the base of the last anal ray. The photophores of the ventral series are distributed as follows: Pre-pectoral 11, P-V 14, V-A 12, A-C 12.

Scales and Skin: All of the scales and most of the skin have been torn away.

Discussion: *P. nonsuchae* agrees with the generic description of *Photichthys* except in the following points: the vomerine teeth are

Fig. 12. *Saccopharynx harrisoni* sp. nov.

extremely rudimentary instead of well-developed and there are but 14 rays in the anal instead of 23 to 26. It differs from *P. argenteus,* the only species previously described, in its greater depth, longer head, larger eye, narrower interorbital width, longer snout, and fewer photophores. Comparative measurements illustrating these differences are as follows:

	P. nonsuchae	*P. argenteus* (according to Günther, Brauer, and Norman)
Depth in length	4.9	5.8 to 6.5
Least caudal depth in length	11.9	16.5 to 21.3
Head in length	3.3	3.8 to 4.8
Eye in head	3.3	4.0 to 5.0
Interorbital in head	5.9	5.0
Snout in head	4.1	5.0 to 5.1
Gill-rakers	5 + 13	5 + 11
Brr. photophores	14	21
Ventral photophores:		
V-A	12	15 to 17
A-C	12	16 to 18
Lateral photophores:		
Entire series	31	33 to 34
Position of last photophore	Above 14th anal ray	Above 6th to 10th anal ray

Saccopharynx harrisoni sp. nov.

Type: No. 20,802 *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1010; *June* 11, 1931; *ten miles Southeast of Nonsuch, Bermuda;* 900 *fathoms; total length* 1400 *mm. or* 55 *inches.*

Field Characters: A large-mouthed, extremely elongate, eel-like, black fish; teeth numerous and moderate in size; eyes and pectoral fins present; an elaborate and highly colored, laterally-flattened, luminous organ near the tip of the tail.

Measurements and Counts: Length (total and standard) 1400 mm. (55 inches); head and body 375 mm. (15.7 inches); tail 1025 mm. (39.3 inches); depth, just behind distended stomach 22 mm. (in length 63.6); depth 260 mm. from tail tip, 3 mm.; head to gill openings 113 (in length 12.3); eye 7 (in head 16); snout 12 (in head 9.4); maxillary 85 (in head 1.3); pectoral rays 33; pectoral length 15 mm.

General Description: The general body shape is that of an elongate black sausage, due to a large sized fish which was still undigested in

the stomach; the head, in profile, shows a slight convexity over the crown, and rises slightly to the tip of the snout; this is sharp and the profile of both jaws is a strong curve; the mandible is slender and curves up, shutting closely against the upper jaw. The eye is well-developed and has undoubted vision; the nostrils are large, half-way between the eye and snout, and close together. The anterior is slightly the larger, and each is surrounded by a raised, rounded rim. The gill opening is in the form of a long, narrow slit, 20 mm. in length, beginning at mid-pectoral, between them, and extending far forward.

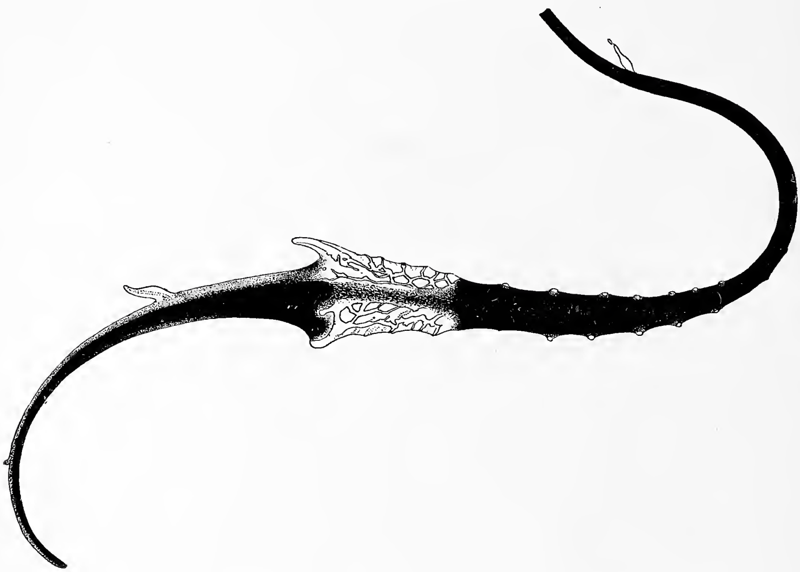


Fig. 13. *Saccopharynx harrisoni* sp. nov. Luminous caudal organ.

Teeth: There are 38 teeth in each half upper jaw, in two irregular rows, those in the outer row much smaller. In each half lower jaw are 30 teeth, in a single row, a large and a small tooth alternating with perfect regularity; the mandibular teeth do not reach very far back and disappear well behind the narrow, upturned symphysis. All the teeth are smooth-edged, but the sides show many irregular striae. The base of each is oval, arising abruptly from a slightly larger, flat, oval sub-base. Some are curved and fang-like, others straight, and they are set rather loosely in the jaws. The largest is 2.5 mm. long.

The skin of the top of the head, the anterior cheeks and around

the maxillary is smooth; all the rest of the skin of head, body, and tail is furrowed with a multitude of longitudinal and criss-cross wrinkles. The fish is jet black except for the specialized, luminous tissue near the tail tip, which is pink, deepening to blood red and dark purple around the base.

The dorsal fin begins far back on the body, just in front of the perpendicular of the anus—the latter opening occurring at about the 12th ray. The anal fin begins 20 mm. behind the anus. The dorsal rays are slightly larger than those of the anal, all are webbed and both fins die out about 200 mm. from the tail tip. The pectorals are paddle-like, with a thick, fleshy, basal pad, and a band of short rays around the free circumference. These are 33 in number and average 3.5 mm. in length. The pad is 10 by 15 mm.

Skin Glands: A few small tentacles are scattered along the lips and on the head,—and on the sides of the tail, from near its base to more than halfway to the tip, similar small tentacles are arranged at equal and frequent distances. At first they are often in pairs but farther along they occur singly, opposite one another, on the midline, about 10 mm. apart. These are not luminescent.

Luminous Structures: On top of the head, 45 mm. back of the snout, a curious structure arises and extends the entire length of the body to within 500 mm. of the tail tip. It consists of two deep troughs, sunk somewhat below the level of the skin and made considerably deeper by rounded, raised rims. Along the back these are very close together, separated by a septum only as wide as the exterior bounding rims. Toward the beginning of the tail these troughs separate and when the dorsal fin begins between them, they are well apart. Half-way down the tail they are 7 mm. apart. Each trough is filled with a bluish white luminous substance. When the fish was taken into the darkroom on its first arrival, a very distinct pale glow was visible along the back, but nothing whatever further back. The dorsal fin rays are each accompanied by a pair of scars or oblique slashes, each of which also contains the whitish substance.

Beginning some distance from the tip of the tail (150 mm.) is a succession of most remarkable structures, positively luminous as I found in the darkroom just before, or at the moment of death of the fish. The first, which is a considerable distance beyond the last finray, is a single pink tentacle, an elongate spindle with a tiny bead at the

tip, arising from the ventral profile. At this point the fish attains its shallowest depth, the tail here being compressed and only 2 mm. deep. For some distance farther the tail is smooth, then, 60 mm. from the tentacle, it begins to broaden and from the dorsal and ventral edges arise thirteen scarlet papillae, on the summit of low mounds almost devoid of black pigment. There are six on the dorsal and seven on the ventral profile. The small mounds are three to four of their base-lengths apart, not symmetrically placed with regard to those of the opposite side.

At an equal distance beyond these begins a most amazing luminous organ, a leaf-like, compressed, almost transparent zone, traversed with a network of large blood vessels. Posteriorly the dorsal and ventral tips are prolonged into exaggerated, finger-like imitations of the preceding papillae. These are scarlet pigmented, not pink with the blood like the rest of the organ. A central longitudinal band of scarlet-dotted, purplish black divides the organ into two. The dorsal finger is much the longer and freer, and there are two more of these dorsal structures trisecting the remainder of the tail. Beyond the leaf organ the tail rapidly diminishes in size, and shows considerable scarlet and purple arranged along both profiles, the scarlet dominant from the last finger-papilla to the tip.

The fish was caught by its teeth in the very collar of the net at the ring, and was saved from swimming away only by being jerked back as the net reached the surface,—a hint probably of how many of the larger fish escape. It was alive and fairly active, opening and closing its jaws, wriggling its body feebly and ejecting a large, half-digested fish. It died just as it reached the laboratory and when we were examining it in the darkroom.

In addition to the faint, colorless glow from the nuchal troughs, we distinctly saw a faint pinkish glow and twice a flash from the specialized caudal organ, and also from several of the scarlet papillae. Under the lens I could later see blood corpuscles moving very slowly along the exposed veins.

Part of the end of the intestine was everted at the anus and I drew out a considerable section together with a second ten-inch digested fish. The stomach had rather thick walls, and numerous longitudinal glandular ridges, the entire mucus lining being wrinkled with very fine, meandering lines and creases.

I have named this fish in honor of Harrison Williams, Esq., through whose continued interest and support these Bermuda Oceanographic Expeditions have been made possible.

Lampanyctus polyphotis sp. nov.

Type: No. 10,151, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 124; *May* 25, 1929; 5 *miles south of Nonsuch;* 900 *fathoms; Standard length* 40 *mm.*

Measurements and Counts: Total length 49; standard length 40; depth 8.2 (in length 4.9); head 12.6 (in length 3.2); eye 3.9 (in head 3.2) snout 2.2 (in head 5.7); mandible 8.6 (in head 1.5, in length 4.7);

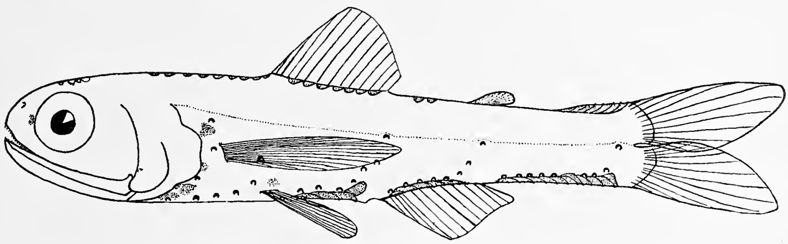


Fig. 14. *Lampanyctus polyphotis* sp. nov.

pectoral 14; ventral 8, origin immediately under that of dorsal; dorsal 13½; anal 14, origin slightly in advance of end of base of dorsal; about 36 scales in the lateral line.

Photophores: PLO slightly below lateral line; 2 PVO in an oblique line, the upper in front of the upper pectoral rays, the lower entirely below the pectoral fin, above the second PO. 5 PO's, the fifth elevated. VLO nearer to base of ventral fin than to lateral line. 5 VO, the first lowered, the fifth elevated. 3 SAO in a broadly angulate series, with the uppermost photophore touching the lateral line and the lower above and slightly behind the fifth VO. AO's 6 + 6. The posterior part of the anal series is entirely behind the base of the anal fin. 2 POL, the upper in contact with the lateral line. 4 PRC, the distance between the first and third about equal to that between the third and fourth. Fourth PRC in contact with lateral line above and slightly behind the third.

Luminous patches and plates: There are 6 small patches arranged

in a circle on the top of the head. In front of the dorsal fin is a single median row of 9 luminous plates, none overlapping. Along the right side of the dorsal are found 8 plates, slightly imbricated, while there are but 7 on the left. About midway between the end of the dorsal and the origin of the adipose are two unpaired plates. There are 7 supra-caudal plates. On the ventral half of the body luminous plates are arranged as follows: There are five plates of various shapes and sizes on each side of the throat, below and in advance of the upper PVO. A similar one is placed above the base of the pectoral fin, while there is a very small patch above the base of the ventral fin. Along the ventral mid-line between the ventrals and the anus are four imbricated plates. Continuous with these is a single pair, consisting of one plate on each side elevated to border the anus. 6 plates, as closely imbricated as those of the caudal series, are found on each side of the anal base. The 12 infra-caudal plates occupy almost the entire space between the end of the anal and the base of the caudal fins.

Discussion: This species seems to be about midway between *Lampanyctus townsendi* (Eigenmann & Eigenmann) of the Atlantic and Indian Oceans and *Lampanyctus maderensis* (Lowe) of the Mediterranean. It may be distinguished immediately from both by the combination of a median series of plates in front of the dorsal fin (characteristic of *L. maderensis*) with a mid-ventral series of plates, exactly similar to those of *L. townsendi,* between the ventrals and the origin of the anal fin.

Lampanyctus septilucis sp. nov.

Type: No. 14,292a; *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 250; *July* 4, 1929; *7 miles south-south-west of Nonsuch;* 700 *fathoms; Standard length* 26.8 *mm.*

Measurements and Counts: Total length 32 mm.; standard length 26.8 mm.; depth 4.7 (in length 5.7 or 17.5%); head 8.0 (in length 3.4 or 30%); eye 1.4 (in head 5.7 or 17.5%, in length 19.2 or 5.2%) snout 1.3 (in head 6.2 or 16.2%, in length 20.6 or 4.8%); maxillary 5.9 (in head 1.4 or 74%, in length 4.5 or 22%); caudal peduncle length 6.0; least caudal peduncle depth 2.4 (in caudal peduncle length 2.5 or 40%, in standard length 11.2 or 9%); distance from snout to dorsal 12.0 (in length 2.2 or 45%); distance from snout to adipose 20.3 (in length

1.3 or 76%); distance from snout to base of ventral 11.2 (in length 2.4 or 42%); distance from snout to anal origin 15.3 (in length 1.8 or 57%); pectoral 15; ventral 8, origin under in front of dorsal; dorsal 12; anal 18½, origin under next to last dorsal ray; about 39 scales in lateral line; 5-13 gill-rakers.

Photophores: 1 minute preorbital photophore between eye and lower part of nostril. 3 or 4 very small post-orbital photophores. 1 shoulder photophore slightly anterior to the most dorsal part of the opercular margin. PLO close to lateral line. Upper PVO opposite upper pectoral rays. Lower PVO somewhat behind upper PVO. 5 PO's, the fourth elevated to the height of the upper pectoral rays.

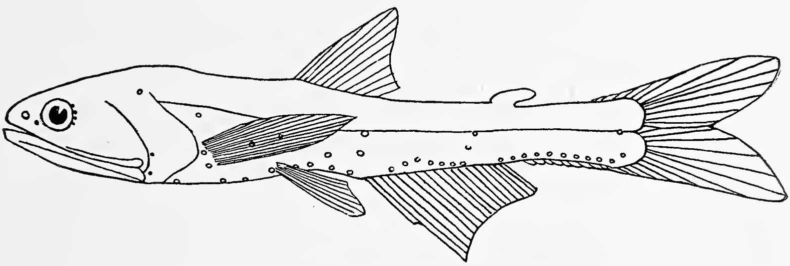


Fig. 15. *Lampanyctus septilucis* sp. nov.

VLO above ventral fin, nearer to lateral line than base of fin. 4 VO's, the second almost imperceptibly elevated. 3 SAO's, strongly angulate, the first slightly in front of the third VO. 7 anterior AO's on the left side, 6 on the right; the second, third, fourth and fifth elevated. 8 posterior AO's on the left side, 9 on the right; the first above the last and second from last anal rays respectively. 2 POL'S, the upper in contact with the lateral line. 4 PRC's, not distinct from posterior AO's; the distance between the third and fourth is about equal to that between the first and third; the fourth is in the lateral line slightly in front of the third. 3 supra-caudal, 9 infra-caudal luminous scales.

Comparison: A second specimen, 14,292b, standard length 27.6 mm., was taken in the same net with the type; and a third, No. 14,061, standard length 29.1 mm., in net 511 on September 27, 1929, thirteen miles south-east of Nonsuch in 700 fathoms. Neither differs perceptibly from the type either in proportions or arrangement of photo-

phores except in the following points: In the second specimen only one small, indistinct, post-orbital photophore is visible instead of the three or four comparatively distinct ones found in the type and in the third specimen. In both the second and third specimens there are seven anterior and eight posterior AO's on each side, instead of the asymmetrical arrangement found in the type. In the third specimen all of the anterior AO's are in a straight line, instead of the second, third, fourth and fifth photophores of the series being elevated.

Discussion: This species is most closely related to *Lampanyctus macropterus* Brauer of the Atlantic, Pacific and Indian Oceans, though it combines certain of the characteristics of *Lampanyctus omostigma* Gilbert 1908 from the tropical Pacific, *Lampanyctus omostigma parvicauda* Parr, 1931 from the western coast of Central America and *Lampanyctus nobilis* Taaning 1928 from the North Atlantic and Pacific. All are set off from the rest of the species of *Lampanyctus* by the combination of long and well-developed pectoral fins, a single luminous organ on each shoulder, but none on the cheeks, the elevated fourth PO, and the confinement of the luminous scales to the caudal peduncle. However, the present species may easily be distinguished from the other four forms by the following points: The VO's are in an almost straight line with the second barely perceptibly if at all raised, instead of having the second noticeably elevated. There are seven anterior AO's (except on the right side of the type specimen), instead of from four to six. The fourth PRC is located in the lateral line slightly in advance of the third, instead of behind it. Finally, the new species has fifteen pectoral rays instead of thirteen.

The following table is a comparison of the fins, number of scales in the lateral line, and the photophores of the new species with those of *Lampanyctus macropterus* and *Lampanyctus omostigma omostigma:*

	L. septilucis (*type*)	*L. macropterus* of Brauer and Parr	*L. omostigma*
Dorsal	12	12 to 14	14
Anal	18½	18 to 19	18
Origin of anal	Under next to last dorsal ray	Under middle of dorsal	Under next to last dorsal ray
Pectoral	15	13	13
Ventral	8	8	9
Lateral line scales	about 39	35	39

Photophores

Postorbital	3 or 4, very small	None mentioned.	None mentioned.
Preorbital	As in *L. macropterus* and *L. omostigma*	1 minute photophore between eye and lower part of nostril.	
Shoulder	As in *L. macropterus* and *L. omostigma.*	1 between upper part of praeoperculum and operculum.	
PLO	As in *L. macropterus.*	Close to lat. line.	2/3 as far from lat. line as from pectoral base.
PVO-upper	As in *L. omostigma.*	Opposite middle pectoral rays.	Opposite upper pectoral rays.
PVO-lower	As in *L. macropterus.*	Somewhat behind upper PVO.	Almost directly beneath upper PVO.
PO's	As in *L. macropterus.*	5. 4th elevated to height of upper pectoral rays.	5. 4th elevated to height of lower middle pectoral rays.
VLO	As in *L. macropterus* and *L. omostigma.*	Above ventral fin, nearer to lateral line than base of fin.	
VO's	4. 2nd scarcely elevated.	4. 2nd well elevated.	4. 2nd well elevated and above or slightly in advance of 1st. 3rd also elevated.
SAO's	As in *L. macropterus* (1st SAO in front of 3rd VO as in Brauer)	3. Strongly angulate. 1st slightly before or behind 3rd VO.	3. Not so sharply angulate. 1st behind 3rd VO.
AO's-anterior	7 on left side, 6 on right. 2nd, 3rd, 4th and 5th slightly elevated.	4 to 6. 2nd, 3rd, and 4th elevated.	5. 2nd, 3rd, and 4th elevated.
AO's-posterior	8 on left side, 9 on right. 1st above last and 2nd from last anal ray respectively.	8 to 10. First above next to last or 2nd from last anal ray.	8 or 9. First above 2nd from last anal ray.
POL's	As in *L. macropterus* and *L. omostigma* (except that upper organ barely touches lateral line).	2. Upper in contact with lateral line. (Gilbert counts lower POL as the 6th anterior AO).	
PRC's	4. Continuous with posterior AO's. 4th in lateral line slightly in advance of 3rd.	4. Distinct from posterior AO's. 4th in contact with lateral line, slightly behind 3rd.	4. Continuous with posterior AO's. Arranged as in *L. macropterus.*
Luminous Scales			
Supra-caudal	3	3 to 4	4
Infra-caudal	9	5 to 10	9

Omosudis lowi

(Post-larva)

Post-larva Number 22,904, *Bermuda Oceanographic Expedition, New York Zoological Society; KOH Cleared Collection No.* 998; *Net* 1245: *August* 31, 1931; *eight miles south-east of Nonsuch;* 1000 *fathoms; standard length* 10 *mm.*

Measurements and Counts: Total length 11.45 mm; standard length 10 mm; depth 2.1 (in length 4.8); head 3.5 (in length 2.88); eye .86 (in head 4); snout 1.3 (in head 2.7); maxillary 2.4 (in head 1.45); pectoral rays .86; pectoral fleshy base .6; anal fin 14 rays; caudal 10 + 9; longest fang .54 mm.

General Description: This young post-larva is white throughout, with a sparse scattering of black dots; a few along the operculars and on top of the brain, and about a dozen down each side of the back, a third the length of the body; a squarish dark saddle on the back in the

center of the highest part of the dorsal fin-fold and just in front of the vertical of the front of the anal; six black dots along the ventral outline in front of the anal. All the fins are hyaline, except the pectoral which is quite dusky. The iris is solid silver, the spicules vertical.

The round protuberant stomach is dusky with thickly clustered,

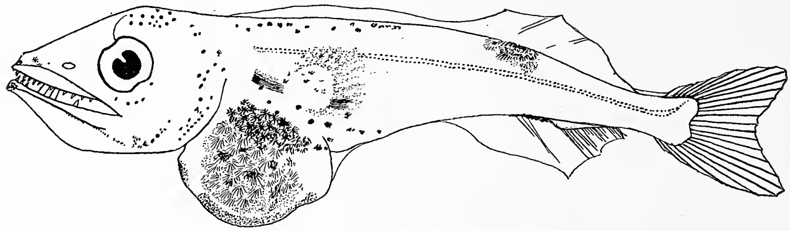


Fig. 16. *Omosudis lowi.* Post-larva of 6.58 mm.

very large dendritic chromatophores, while on top they form a solid black patch. This stomach contained a white, post-larval Myctophid of the same length (10.2 mm) as the *Omosudis.*

Dyed and Cleared: The osteological development at this stage is very interesting. There is not a particle of bone in the entire body,

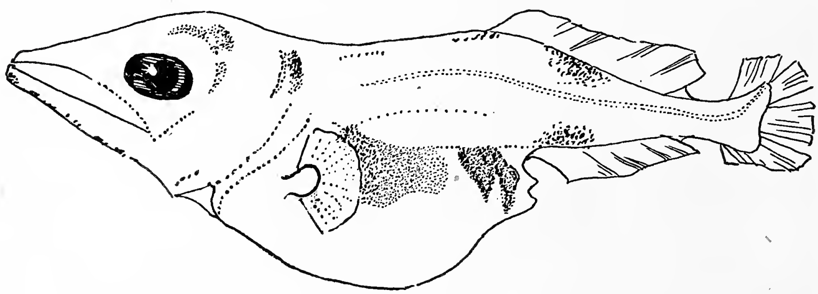


Fig. 17. *Omosudis lowi.* Post-larva of 10 mm.

fins, fin rays or appendicular skeleton, except for a faint trace in the center of the supracleithrum.

The head is set sharply off as a series of elongate, bracing bones, strongly ossified, and forming a nearly perfect equilateral triangle, the corners being the posterior borders of the frontals, the snout and the quadrate.

The entire top of the head is covered with the thin but well-ossified frontals, broad and rounded behind, and narrowing as they extend forward, until their needle tips actually touch the lateral, flaring, wing-like, superior edge of the still unjoined premaxillaries; a strongly ossified, buttressed ridge begins at the postero-lateral rim of the frontals where it shows two branches at right angles, and extends down the entire length of these bones. Its upper edge is looped from one body brace to another as far as mid-eye, and crenulated after that. The parietals show only as small oval, faintly pink cartilage; the sphenotics are better ossified and show a low, sharp spine; only the basal condyle of the opercular is ossified, the remainder being clearly outlined in cartilage; the hyomandibular is ossified only on the anterior edges; the preopercle is strongly ossified, beginning as a needlepoint in front of the opercular condyle and extending clear to the quadrate, slightly bowed, flaring in the posterior lower half into a broad, looped, bony web between strong spines.

The premaxillaries are not united at the symphysis; they extend back as the slenderest needles of bone, three-fourths of the way to the quadrate, with teeth all the way; there are fifteen altogether, the 1st, 3rd, 5th and 7th larger than the rest, the 5th a depressible fang of large size; the edentulous maxillary is a veritable thread of bone, well ossified, and flattening out toward its distal end; the palatine is stronger even than the premaxillary, arising at the vertical of the 5th tooth on the premaxillary, and extending back to beyond the vertical of the mid-eye; it bears five teeth longer than most of those in the upper jaw; posteriorly the palatine is overlapped by the slender spindle of the mesopterygoid, and this by the larger pterygoid.

The dentary is as strongly ossified as the premaxillary, and its two posterior forks reach almost to the quadrate; in the extreme front are two moderate-sized teeth, followed after a space by very tiny teeth; halfway down the jaw is a single enormous fang, with an auxiliary tooth of equal size just behind but lying flat, and ossified at the tip; halfway between this and the posterior tip of the upper prong is a single very small tooth, making five in all; the articular is thoroughly ossified only along the lower margin, and merges very closely with the angular; the quadrate, like the opercular, is surprisingly cartilaginous, and only its

condyle and the adjoining area are ossified. The basisphenoid is a strong rod and completes the tale of visible bones in this post-larva.

Post-larva Number 23,073, *Bermuda Oceanographic Expedition New York Zoological Society; Net* 1258; *September* 3, 1931; *eight miles south-east of Nonsuch;* 900 *fathoms; standard length* 6.58 *mm.*

Ossification much the same as in the 10 millimeter specimen, with a diminution in the development of the head bones such as might be expected in a fish one-third less in length. This individual had swallowed a squid quite as large and slightly longer than itself.

Melanonus unipennis sp. nov.

Type: No. 22,397, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1182; *August* 15, 1931; *ten miles south-east of Nonsuch;* 700 *fathoms; standard length* 62.5 *mm.*

Measurements and Counts: Total length 70 mm.; standard length 62.5 mm.; depth 10 (in length 6.25); head 13.5 (in length 4.6) eye 2.8 (in head 4.8); snout 5.2 (in head 2.6); maxillary 8.2 (in head 1.6); interorbital 5.5 (in head 2.46); pectoral 16; pectoral length 8; ventral 7; ventral length 6.4; dorsal 100 (72 + 28); anal 79 (56 + 23); caudal 6; caudal length 7.5; scales 112; branchiostegals 7. Teeth in upper jaw, very numerous, small and in several rows, a few slightly enlarged canines in front; mandibular teeth fewer and larger, in two irregular rows, the inner row much larger than the outer.

Comparison: All the fifty-odd specimens of *Melanonus* which have been taken at our station show a united dorsal fin. There is no sign of division into two, between the first six to eight and all the remaining rays. Comparison must be made with *M. zugmayeri* of Norman as he distinguishes it from the type and other specimens of *M. gracilis* as the only one occurring in the North Atlantic.

The depth of my specimen is much less than that of *zugmayeri* (6.25, not 4.9); the head is smaller (4.6, not 4); the snout is longer (2.6, not 3.5); the dorsal fin is slightly larger (72, not 70) and the anal still more so (56, not 50); the posterior rays of the so-called third dorsal, second anal and caudal are more numerous in my specimen (57, not 50); the pectoral has more rays (16, not 13); and the lateral row of scales is fifteen percent greater in *unipennis* (112, not 80).

Pseudoscopelus stellatus sp. nov.

Type: No. 21,155, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1058; *July 7,* 1931; *eight miles southeast of Nonsuch;* 300 *fathoms; standard length* 23 *mm.*

Field Characters: A small elongate dark-skinned fish, with scattered iridescence, especially strong on the opercles, and a circle of successive rings of brilliant colors on the side, behind the pectoral fin. Double dorsal and elongate anal. Lines of small green chromatophores along the ventral surface from the isthmus to the caudal, small clusters on the mid-mandible, on the lower part of the preopercle, and at the base of the pectoral.

Measurements and Counts: Total length 26.5 mm; standard length 23; depth 4.5 (5.1); head 7.1 (3.2); eye 1.8 (3.9); snout 1.7 (4.2); maxillary 4 (1.8); interorbital 1.8 (3.9); dorsal VII-26; anal 26; pectoral 14; pectoral length 8; ventral 5; ventral length 4.3 mm.

General Color: Purplish brown, with tinge of pink on head and base of caudal; black chromatophores thickly scattered over most of the fish, while on the head and at base of caudal these are mixed with numerous flame-scarlet dots, most conspicuous on upper and lower jaws and in the anterior part of the isthmus. Mouth pale, speckled with black and scarlet inside. Proximal half of dorsal, anal and caudal rays speckled with black, pectorals and ventrals at their bases only.

Iris: Steel blue with greenish reflections and a scattering of black chromatophores around the edge.

Iridescence: Covering much of the fish, but especially strong on the sides of the head and anterior sides; consists of fine spicules on the dermis, in some places well separated from the transparent epidermis which carries the dark chromatophores; peacock blue just behind opercles and in front of ventrals; green in front of pectorals. Behind pectorals, partly beneath the fin-rays and partly above them, a peculiar iridescent area, the general impression being of a large, oval, green, bronze and blue ocellus as large as the eye: center blackish, around which is a ring of gold, then bronzy green, then blue and finally an outer ring of bluish violet. This last color extends forward to the opercle, and backward in a gradually diminishing band between the lateral line and the ventrals as far as the anal fin. Ventrally, along the abdomen, this changes to a greenish-black sheen visible only in some

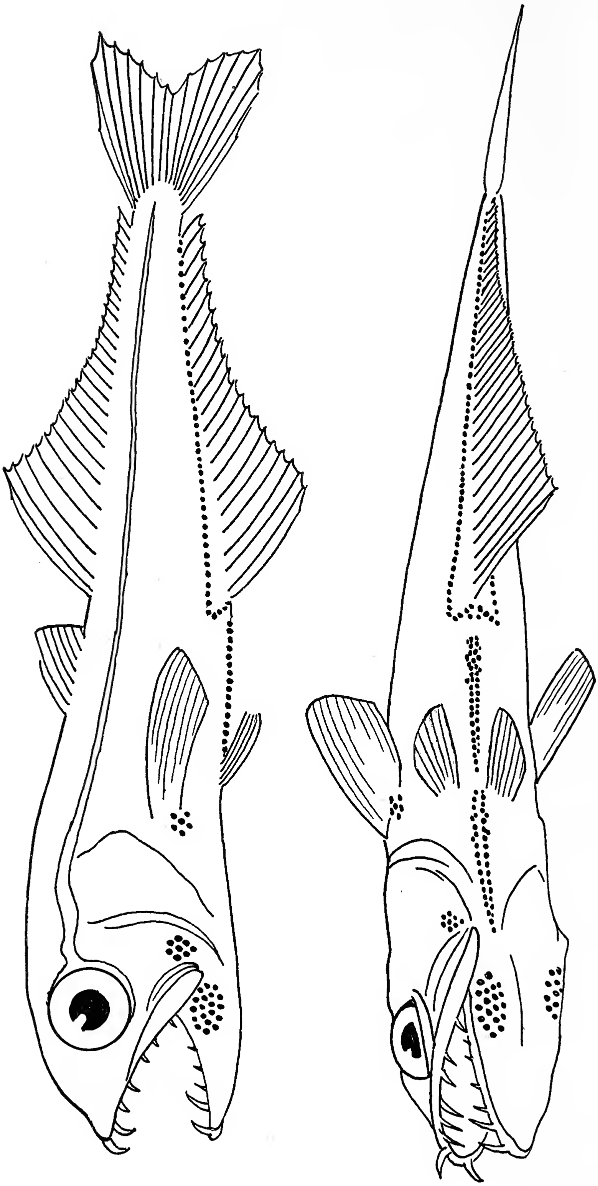


Fig. 18. *Pseudoscopelus stellatus* sp. nov.

lights. Preopercle is shining blue, opercle golden-green. The gills show through the branchiostegal membrane as bright pink.

The lateral line is a deep groove, bordered by a connected series of overlapping fleshy flaps. In life these meet across the lateral line, so that only occasional, separate openings are visible. When relaxed in death the two series of leaves or scallops spread apart and the trough is open throughout. In the fresh specimen a faint bluish iridescence is visible along the lateral line.

After death both body and fins become covered with a complete coat of thick mucus, which is replaced at least twice after being cleaned off.

Photophores: In the fresh fish the numerous photophores (354 altogether) are clear bright green—Night green of Ridgway. The organs are facetted as in those of *Cyclothone,* but from every angle show the same green, clear and intense. Within fifteen minutes after death the lights begin to fade to silvery white, those of the preopercle and mandible long before the ventral body lights.

Photophore Counts: Mandibular—19 in a compact, oval group on each side, beneath and in front of the posterior end of the maxillary.

Preopercular—8, in a small group at the lower tip of the triangle of this bone.

Base of Pectoral Fin—5 and 6, on the two sides respectively. Ventral Midline, Isthmus to Ventrals,—54, mostly in a double row, placed very close together, but with several irregularities.

Ventrals to Anus—47, beginning somewhat behind the ventral fins and ending well in front of the anus; usually in a double row, but irregularly single or triple especially in the extreme anterior and posterior portions.

Circum-anal—Right 89, left 90. This line completely surrounds the anal fin except for a slight break around the posterior end. The line is single except between the anus and the anterior beginning of the fin where it is irregularly double. These photophores are not equally spaced, nor are they all equal in size, and the slight gaps and congested areas do not correspond on right and left sides.

Pre-caudal—9, which are slightly larger than the circum-anal lights and are arranged in an unsymmetrical, roughly Y-shaped group, on the midventral line, just in front of the origin of the caudal fin.

Discussion: *Pseudoscopelus scriptus* was described in 1892 by Lütken (Spolia Atlantica (2) 1892, pp. 284-285) and since then redescribed and pictured by Goode and Bean (Oceanic Ichthyology, 1895, pp. 292-293, figure 266) and Norman (Annals and Magazine of Natural History, 1929, (10) Vol. III, pp. 543-544, figure 11).

Owing to the small size of the photophores and their ultimate superficial obscurance by mucus, all these authors have described them as mucus pores. Norman even omits them from his illustration. Goode and Bean depict them correctly but describe them as "series of closely placed pores" while Norman says in his caption "The rows of small pores on the head and body have been omitted."

Pseudoscopelus stellatus differs from Goode and Bean's description of *Pseudoscopelus scriptus* in various proportions; in having no cross-line of "pores," placed "immediately behind the ventral fins"; and the length of the pectoral fins is not "nearly three times as great" as the ventrals, but less than twice. The illustration shows a line of "pores" along the maxillary and two shorter lines along the mandible, while in *Pseudoscopelus stellatus* these are absent, there being two groups, one on the preopercle, and the other on the mandible. The group of photophores at the base of the pectoral in *Pseudoscopelus stellatus* is wholly lacking in Goode and Bean's illustration.

Norman states "diameter of eye 6, interorbital width nearly 3 in head," while the corresponding proportions in my fish are 3.9 in both cases.

The short rounded snout, the several rows of palatine teeth and the presence of "definite rows of small mucous pores" (= photophores) clearly sets this fish off from *Chiasmodon* and places it in *Pseudoscopelus,* but it very distinctly has the several pairs of anterior, large, recurved, canine fangs supposedly characteristic of the former genus.

Several young *Pseudoscopelus stellatus* have come up in shallow hauls.

No. 21,404, (2), Net 1084, July 15, 1931, are from a depth of twenty-five fathoms. This number includes two fish of 20 and 23 mm. respectively. Although the latter is quite as large as the type yet it is distinctly a larva. In general color both are pale pink with numerous black dots, strongest dorsally. There are strawberry-pink patches in the following positions, similar in both individuals: one at the base of the 1st dorsal, four along the 2nd dorsal, three along the anal, and five

on the midline of the body, distributed evenly from the vertical of the 1st dorsal origin to the base of the caudal. These bright pink spots are thickly peppered with small black chromatophores. The caudal is densely speckled with black.

The iris is silver, edged with black. The opercle shows a strong steel blue, golden and green iridescence. On the sides, and extending down almost to the abdomen is a conspicuous rainbow series of colors, adumbrating the ocellus of the adult. Here, however, it is an elongated, semi-ellipse instead of an oval, and extends from the top of the pectoral base almost to the anal fin. Deep violet ventrally, it ranges through bluish-violet and peacock blue to emerald green and gold.

In both these individuals there is a distinct trace of the ventral photophores, about four pairs between the ventrals and anal, and an equal number at mid-anal. There is also a hint of the cluster of photophores on the mid-mandible. These beginnings are in the form of distinct black centers to very large, dendritic chromatophores. There are also unusually large chromatophores between the anal and caudal, anticipating the irregular peduncular line of light organs. There are two rows of teeth on the palatines, and at the premaxillary symphysis are two pairs of large, sharply bent, backward pointing fangs.

A still younger individual of this species is No. 21,321 of Net No. 1069, hauled on July 10, 1931 from a depth of 50 fathoms. It is 14 mm. standard length, and in general color is white, with oblong, longitudinal patches of grenadine-red chromatophores placed as follows: three along the anal base, one under the anterior dorsal fin, three under the 2nd dorsal, and four along the mid-line between the base of the dorsal and the base of the caudal. The two posterior colored areas of both dorsal and anal fins are each overlaid with two, large, black pigment spots. There is a slight duskiness on the top of head and tip of snout. The fin-rays are white with an irregular sprinkling of black and reddish chromatophores.

The smallest *Pseudoscopelus stellatus* measures 10 mm. in standard length. It is No. 21,456, Net No. 1093, taken July 18, 1931, from 300 fathoms depth. It is translucent white with red spots, one at midbody on the midline and one each at the center of the 2nd dorsal and of the anal. The crown of the head has a group of small, round, black chromatophores. Iris silver, laid thinly over the black of the eyeball.

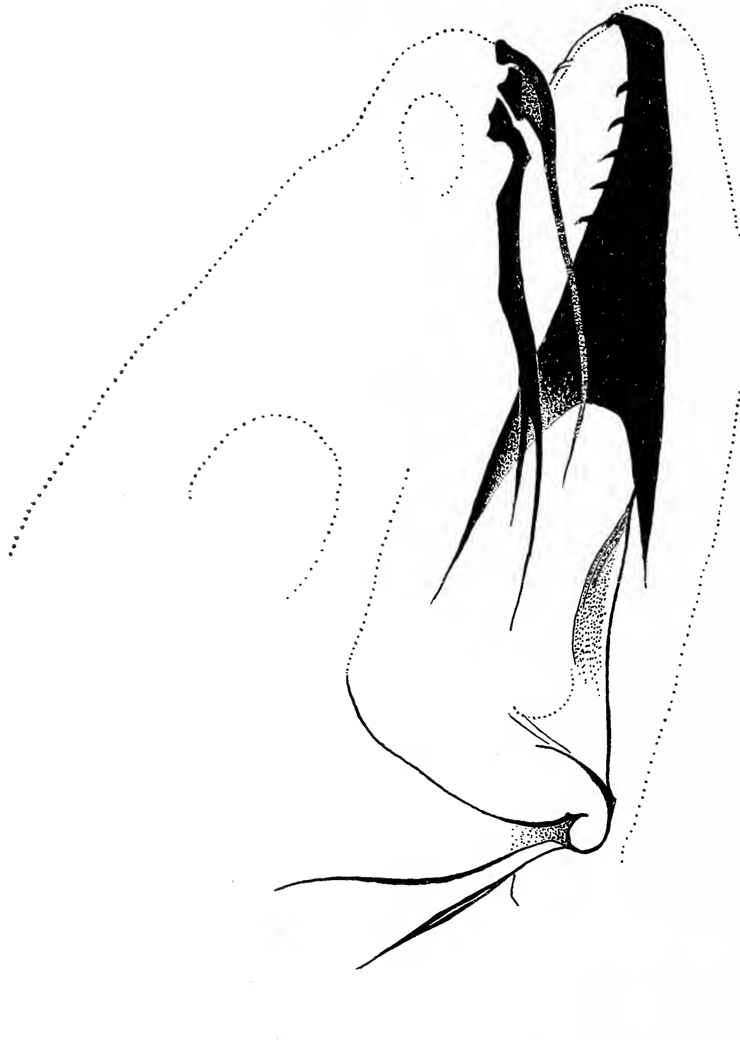


Fig. 19. *Parabrotula dentiens* sp. nov. Jaws.

The following table shows the relative changes in growth in three specimens:

Standard Length	*Head / Length*	*Eye / Head*	*Snout / Head*
10	3.7	3	2.7
20	3.3	4	3.5
23 (Type)	3.2	4	4.2

Parabrotula dentiens sp. nov.

Type: *No.* 15,882, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 692; *June* 12, 1930; *eight miles southeast of Nonsuch Island, Bermuda;* 800 *fathoms; standard length* 28 *mm.*

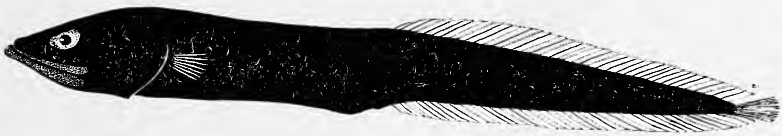


Fig. 20. *Parabrotula dentiens* sp. nov.

Field Characters: A small, black, scaleless, brotulid fish, with large oval eyes, projecting lower jaw, no ventrals, vertical fins beginning at mid-body and continuous with the longer rayed caudal.

Measurements and Counts: Standard length 28 mm.; total length 28.9 mm.; depth 2.7 (in length 10.3); head 4.8 (in length 5.8); eye .86 (in head 5.5); snout 1.5 (in head 3.2); maxillary 2.7 (in head 1.8); mouth angle 20° up; ocular angle 20° up; ocular divergence 25° forward; branchiostegals 6; vertebrae 59 (23 + 36); pectoral 7; pectoral length 1.2 (in head 4); dorsal 41; anal 39; caudal 6; caudal length .9 mm.

General Description: The color is jet black; the body is elongate, the head flattened above, sloping straight down from nape to snout; the eye is large, oblique, oval, covered by thin transparent skin; the gape reaches behind the eye, the lower jaw projecting in front.

The teeth are wholly lacking in the upper jaw, but there are twelve in the lower, small, far apart and bent sharply backward. The skin is thin and scaleless. The vertical fins are composed of soft cartilaginous jointed rays; the pectoral rays are soft and cartilaginous except at the base; the ventrals and the pelvic arch are wholly lacking.

Osteology, from the stained and cleared type: There are 59 vertebrae, 36 of which may be termed caudal. All are well ossified except the two posterior ones, which are cartilaginous, showing faintly, together with a solid caudal basal support, and a hint of urostyle. There is no apparent division between trunk and tail vertebrae except the position of the anus. The neural and haemal arches are well developed, long, and slant slightly backward, but there are no other appendages.

The basis cranii is the only part of the skull to show very evident ossification. The cleithrum and supracleithum are strongly ossified, as are the opercle and interopercle. The other elements are barely visible. The 1st branchiostegal has no visibly ossified point of attachment. From a very faint ceratohyal arise the 2nd and 5th backward curving branchiostegals and a 6th extends almost straight between the two better developed opercular bones. The quadrate is strong.

The premaxilla and maxilla are slender, almost rodlike, the latter ending far from the quadrate, and both are toothless. When any opening pressure is applied to the jaw, it is the upper which opens, the snout wrinkling above, giving along the posterior cartilage. The mandible is remarkably strong, both dentary and angular, and shows but slight downward movement. There are six, very small, widely separated, backwardly directed teeth on each ramus of the former, the first well away from the symphysis. Of the pectoral fin, only the bases and a fraction of the seven rays show any ossification. The dorsal, anal and caudal rays are soft and wholly lacking in bony tissue.

The oesophagus is large and distended, and there is little differentiation into stomach and intestine in the undissected fish.

Much of the body is filled with masses of small oil globules, especially behind the eye, and again behind the aural cavity, over the surface of the body organs, and a solid mass down the bases of the vertical fins, along the entire profile of the body.

Comparison of No. 15,882 with *Parabrotula plagiophthalmus*:

The appended table shows at a glance the difference between my specimen (No. 15,882) and the one described by Zugmayer.* The major distinctions are that my fish, while about the same length, has a much longer anal fin, a shorter pectoral, the body is more slender, the head and eye are smaller, the mouth larger, and there are teeth present.

**Zugmayer, Bull. Oceanogr. No.* 193. *Monaco,* 1911; *Zugmayer, Res. Camp. Scient. Albert First; Fas. XXXV,* 1911, *p.* 129, *Plate VI, fig.* 5.

Monaco's fish was taken at 1500 meters depth, 43° 4′ No. Lat., 19° 42′ West Longitude, about 480 miles north-east of the Azores.

	Parabrotula plagiophthalmus	*P. dentiens* No. 15,882
Standard length	24 mm.	28
Dorsal	40	41
Anal	30	39
Pectoral	7	7
P. length	2.3 mm.	4 mm.
Caudal	5	6
Depth in length	8	10.3
Head in length	4.5	5.8
Mouth in head	2.3	1.8
Maxillary	mid-eye	behind eye
Eye in head	4.3	5.5
Branchiostegals	5	6
Teeth	0	12 in mandible

Chaenophryne crossotus sp. nov.

Type: *Number* 20,809, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1015; *June* 15, 1931; *eight miles south-east of Nonsuch;* 500 *fathoms; standard length* 17 *mm.*

Measurements and Counts: Total length 20.7 mm.; standard length 17 mm.; depth 9.4 (in length 1.8); head 11.4 (in length 1.5); eye 1.5 (in head 7.6); snout 6.8 (in head 1.67); mandible 8.5 (in body 2); pectoral length 2.3; dorsal 7; anal 6; caudal length 3.7; illicium 5.7 (in head 3).

General Description: Outline typically chaenophrynine, strongly arched above, almost flat below, snout short and blunt, peduncle narrow and tapering into caudal; eye small, directed considerably forward; nostril openings at end of small tube near tip of snout; mouth large, almost horizontal, gape well behind eye: Teeth very small and few in number in upper jaw, about five on each ramus; ten on each half mandible, about half of them twice as large as the others, and three times as long as those in the maxillary; three pairs of vomerine teeth; the skin is velvety jet black as are all the fins; the anterior half of the lower lip is pale, fitting into the loose upper lip when the mouth is closed; no spines are visible; the rays of all the fins are encased in black skin, with the brushy tips white.

The illicium base bone is wholly concealed under the skin; the stem emerges close to the tip of the snout, black for half its length, and

becoming pale translucent white where it rises above the deep trough; it widens anteriorly into the large bulb, the posterior profile remaining straight; a brown inner core occupies about a third of the posterior aspect of the translucent stem, and flares quickly into the oval, blue-black bulb; at the upper end of the bulb there arises a pair of black spheres balanced side by side on the end of short stalks; immediately behind them is a small saddle-shaped black mark; at the postero-

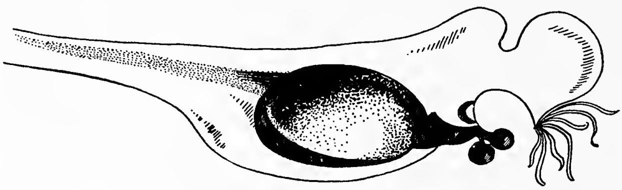


Fig. 21. *Chaenophryne crossotus* sp. nov.

superior edge of the illicium a broad high translucent, white crest arises, divided mid-way by a deep posterior notch and flaring out distally into a round comb, with an anterior point from which springs a tuft of seven, slender, thread-like white tentacles.

Chaenophryne draco sp. nov.

Type: 22,396, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1181, *August* 15, 1931; *ten miles south-east of Nonsuch;* 600 *fathoms; standard length* 18 *mm.*

Measurements and Counts: Total length 23 mm.; standard length 18 mm.; width 10 (in length 1.8); depth 9.7 (in length 1.85); head 12 (in length 1.5); eye .8 (in head 15); snout 4.5 (in head 2.6); maxillary 4.3 (in head 2.8); visible dorsal rays 4; visible anal rays 2; pectoral 18; pectoral length 2.1; caudal 9; caudal length 5; illicium length 6.4.

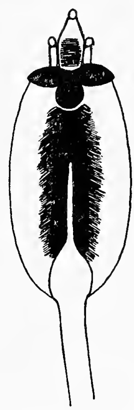
General Description: Snout rising from upper jaw almost vertically, then continuing into the long, even dorsal curve which straightens out gradually to the tail; the ventral outline is almost horizontal; eye rather small, just back of the gape, half-way between the gape and the dorsal outline; nostril on a low tubercle, close to tip of snout; mouth large, horizontal.

Teeth very small and few in number in the upper jaw, six in each

ramus; those of the lower jaw are two to three times as long, and nine to ten in each half jaw, four of these being long curved fangs; there are three pairs of vomerine teeth, strongly graduated, the smallest in front.

The skin is jet black, with a surface which looks like the nap of black velvet, except the lips which are smooth and dark brown; the fins are all black, only the illicium is different in color. There are no surface glands visible and spines are wholly lacking, although the infra-

Fig. 22. *Chaenophryne draco* sp. nov. Illicium at right.



posterior mandible angle is clearly indicated through the skin. The rays of the ventral fins are low and inconspicuous and probably not all project through the outer skin; each is enclosed in a black sheath, but bare at the tip, like the rays of the pectoral and caudal.

The illicium is a very complex organ, but lacks elaborate tubercles. The basal bone arises half way between the vertical of the eyes and the snout, but is visible only from above and that for but a short portion of its length; posteriorly it disappears at once beneath the skin, although the outer skin itself is devoid of pigment for a short distance farther; it then sinks below the surface, leaving a deep, narrow, epidermal furrow which persists on the top of the skull, to a point well behind the eyes. From above, the anterior profile of the elbow of the basal bone and the illicium stem just reaches the vertical of the tip of the snout;

the stem is translucent, pale purplish blue, the terminal bulb convex anteriorly, the stem continuing straight up behind; at the anterior base of the bulb is a large, round pad of pinkish-white, silvery spicules, sending a long, narrow extension upward; beneath this is an ebony plaque, on each side of which the silvery spicules extend up from below, ending in an irregular edge on the black. Distally, where the line of spicules dies out, a new and complex structure begins; on mid-body is a rounded, black flap like the full-spread tail of a bird lined along the edge with silver, while from each side sprout two moderately elongate black wings, thickly mottled with brown; beyond there is a thick, tubular body, extending to the anterior tip of the illicium, black, graying gradually to white at the end; on each side near the base of this tube in advance of the wings and projecting back beneath them, are two smaller tubes of pale bluish, each ending in a plug of silvery spicules; beneath the median terminal, tubular body and separate from it, is a fin-like extension of the translucent, bluish-purple tissue, transverse like the fin of a squid.

Dolopichthys gladisfenae sp. nov.

Type: *No.* 15,490, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 639; *May* 28, 1930; *six miles south of Nonsuch Island, Bermuda;* 700 *fathoms; standard length* 40 *mm.*

Field Characters: A somewhat elongated Dolopichthid, articular spines absent, skin spiny, teeth few, dorsal 5, anal 5, illicium 4.7 in length, bulb structure complicated.

Measurements and Counts: Standard length 40 mm; total length 54 mm.; depth 16 (in length 2.5); head, to gill openings 20.7 (in length 1.9); eye 1.1 (in maxillary 4.5); snout 3.3 (in maxillary 1.5); maxillary 5 (in length 8); intersphenotic 7.1; mouth angle 30° up; ocular angle 15° up; ocular divergence 10° forward; pectoral length 3.8; dorsal 5; anal 5; caudal 9 (2+4+3); caudal length 14; illicium 8.5 (in length 4.7); basal bone 3.1 mm.

General Description: The fish is elongate and moderately deep; the back is parallel with the ventral outline, almost horizontal; the anterior profile shows a slight downward curve from sphenotic to snout; the head is elongate, somewhat flattened above and below; the interorbital to the snout is free of spines, longitudinally elevated, with a

deep groove down the center; the snout is round in profile, flattened above; the eye is small, the nostril is a thick, short tubercle, placed two-thirds of the distance from eye to illicium; the mouth is moderately large, terminal and oblique; the maxillary reaches the front of the eye.

The teeth consist of nine small, sharp, subequal pairs in the upper jaw, set in a deep, wide groove formed by the rounded lips on one side, and an inwardly stretched, dark, dermal velum within; there are twelve pairs of larger teeth, graduated in threes, in the lower jaw; three vomerine teeth are visible on each side, strongly graduated, the shortest toward the mid-line.

The skin is smooth on the illicium, lips and a wide area from behind the sphenotic spines forward to the mouth; everywhere else it is beset thickly with small spines, and a scattering of mucus glands in the form of short, stout tubercles (as in *Cryptosparas*) ; the articular spines are absent; the sphenotics are small and sharp, projecting less than 2 mm. above the surrounding surface, about half of the height free of skin; the dorsal and anal fins have low, separate rays, very broad at the base, tapering to an exposed, fine point, useless for swimming; the pectorals are short, thickset, of thirteen rays.

Illicium: The illicium arises from near the tip of the snout, directed low and obliquely forward. It is jet black to the first joint, the pigment then thinning out, only along the sides reaching the base of the bulb as a faint duskiness. Above and below, the stem becomes abruptly milky white. The core is dark and upon its tip is placed the bulb, rounded except on the bottom which is flattened and curved inward to the core. The bulb is jet black with the basal half covered with iridescent, glittering spicule scales, silver, green and bronze, arranged with their long axes concentrically. The top of the bulb is of pale, lemon yellow, luminescent material, with the center changing abruptly to bright yellow, and from each side of the base of this a triangle of the glittering scales extends down over the black area. Above the cap and close to it, there arise from the center three flat, horizontal, fan-shaped disks of the luminous yellow. All the structures thus far mentioned are included in the coating of translucent, milky tissue.

Viewed from above, the bulb shows its lower half and a thin line around the cap covered with the glittering scales, elsewhere jet black. In the center, the black of the bulb rises a little, and is capped by a tiny mound of the bright scales. Above this the protecting tissue

(which shows transparent in a downward view over the bulb) is drawn up into a point, tipped with three finger-like tubercles, turning white at the tips. Beneath there is a misty, pale green tissue, very delicate, looking like a puff of pale green smoke. The lemon cap is split down the center fore and aft, and the green mist disappears into the anterior part of this crevice, where it becomes a deeper emerald green. Suspended above this is an intricate, silvery scaled structure like a bird in flight—the head of the bird with three black dots, close behind the base of the green smoke, the silvery wings stretched wide on each side. The body above and behind is encased by the mass of tentacular matter—the large rounded, elongated, thick projection, with a similar, smaller one directly behind, both composed of delicate, cobwebby, frosted tissue. Halfway down the larger, many small isolated, pale pink tentacles appear (28 are visible at once from one angle), and these increase in number, complexity and length, and become deep pink, until the two terminal projections, the body and half the wings of the silver bird, are buried in a mist of pink. Posterially, behind and below the second protuberance, two long finger-like tentacles arise, widely separated from the grey covering tissue.

Dolopichthys tentaculatus sp. nov.

Type: *No.* 23,170, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1271; *September 7th,* 1931; *ten miles south-east of Nonsuch;* 600 *fathoms; standard length* 13.5 *mm.*

Measurements and Counts: Total length 19.5 mm.; standard length 13.5 mm.; depth 7 (in length 1.9); head 9.3 (in length 1.4); eye .86 (in head 18); snout 2.1 (in head 4.4); mandible 5.7 (in head 1.6); pectoral rays 18; pectoral length 2.4; dorsal 4; anal 4; caudal rays 9; caudal length 6; illicium basal bone 1.8; stem and bulb 2.8; dorsal illicium tentacle 4 mm.

Description: Body typically dolopichthine in shape, enormous, high-arched head and back, horizontal ventral surface; pectoral and caudal fins well-developed and functional; vertical fins with barely projecting tips, wholly useless; sphenotic and articular spines prominent; quadrate and mandibular spines small, the former slightly the larger. Basal bone of illicium arising halfway between eyes and tip of snout, extending well in front of snout and jaw.

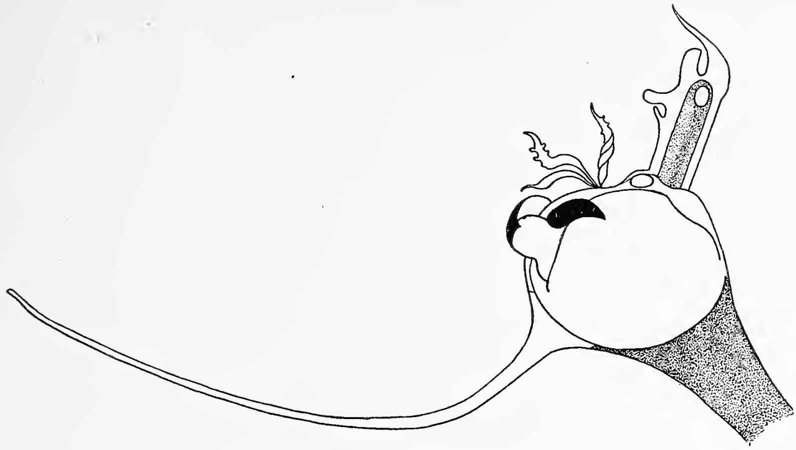


Fig. 23. *Dolopichthys tentaculatus* sp. nov.

Body, all fins, basal bone and proximal half of illicium stem dark seal brown; iris dark blue with a scattering of silver spicules; teeth transparent, colorless. The brown of the illicium stem includes about one-third of the bulb, the distal two-thirds being blue-black. From the dorsal side of the bulb (in its usual forward pointing position) arises, at right angles, a long, slender, pliable, colorless, translucent tentacle, tapering only slightly; from the opposite, ventral side of the bulb springs a rather stout, even-sided projection, pale brown except at the tip where it shows two, lateral, luminous facets. The whole structure is included in the translucent tissue, very thin along the brown part, but extending beyond the tip in two protuberances, one above the other, the upper a short, colorless tubercle, the lower a longer, upturned curved tentacle. From the upper part near the extremity of the brown tube arise two small, luminescent tubercles. There is a second pair of luminous facets on the bulb near the base of the tube.

Between the elongate dorsal tentacle and the ventral tube the blue-black of the bulb is split vertically, showing silvery tissue, and giving rise to several specialized organs. Near the base of the long tentacle there is a widening of the sub-silver, and this same tissue is raised above the level of the bulb into a thick, flat-topped comb, the summit of which is black; at the anterior base of this comb two large flat, triangular leaves of black tissue arise, and extend out, over and

above the surface of the bulb. Halfway between their bases and the tube-like, ventral luminous organ three, slender-stemmed, translucent, twisted leaves spring from a single base.

Mandibular teeth are very long and slender, the tips slightly incurved; there are thirteen in each half-jaw, graded in size by two's and three's; the teeth of the upper jaw are small and fewer in number, nine or ten on each side. Three good-sized teeth on vomer.

Comparison: This is closest to *Dolopichthys obtusus* the type of which is excellent for comparison for it is of exactly the same size. Among other dissimilarities each species has a different arrangement of structures on the illicium bulb and, curiously, the arrangement is reversed.

Linophryne arborifer Regan
(Post-larva)

Specimen No. 22,400, *Bermuda Oceanographic Expedition, New York Zoological Society; Net Number* 1182; *August* 15, 1931; *ten miles south-east of Nonsuch Island; 700 fathoms; standard length 27 mm.*

Field Characters: An oval fish; translucent, bluish white outer balloon skin; fins, lips and eye-sockets white; eye well-developed; teeth moderate; illicium bulb and mental barbel just through epidermis; sphenotic, quadrate and mandibular spines clearly visible; anus sinistral.

General Measurements and Counts: Total length 35.7 mm.; standard length 27 mm.; depth 18.8 (in length 1.4); depth, inner body 10 (in outer depth 1.8); head 15 (in length 1.8); eye 1.7 (in head 8.8); snout 4 (in head 3.75); maxillary 5.7 (in head 2.6); pectoral 14; pectoral length 2.8; dorsal 3; dorsal length, total 7.1, external length 21; anal 3, total length 7.1, external length 28; illicium stem and bulb 2.8; bulb diameter .8 mm.

General Description: External profile an almost regular oval, dorsal and ventral surfaces equally curved; snout drops almost vertically to lip; eye large, well-developed, the only black tissue about the fish, the eyeball bluish black, iris with silvery spicules, densest below, dying out on the outer half of the sides and the top; nostrils a little nearer apex of snout than eye, both openings very small and on the summit

of a long, thin narial stalk arising from the skull proper, at the same vertical as the illicium stem; mouth moderate, the gape reaching to mid-eye, slanting up 20 degrees.

Teeth: At the premaxillary symphysis there is a deep bay, the inner rim of which is lined with two teeth; along the outside are four or five very small, straight teeth; along each half jaw are 18 to 20 inwardly curved teeth, the anterior ones largest; some of these are arranged in double rows hinting of the several oblique lines in the adult, and five or six are obviously replacement teeth, each ready to take the place of its companion when it falls out.

The teeth in the lower jaw are very similar to those in the upper, except that there are only three anterior, small straight teeth, there is no symphysial bay, and the anterior three or four pairs of canines are larger than any in the upper jaw. The velum within the upper jaw is so wide that the roof of the mouth cannot be seen.

The outer skin is smooth and covered with an infinity of minute black dots which gives it a grey appearance. Along the sides of the head and body is a sparse scattering of numerous, small, dark, dendritic chromatophores, which die out gradually at the vertical of the eye and gape, the anus, and the dorsal and ventral outlines. They are thickest around the gill-openings. Of the internal body, the region of the eye, snout, post-brain, and whole vertebral body are unspotted white, with a few, large chromatophores on the side of the peduncle. The upper surface of the brain and the opercular region have many large chromatophores, and there is a black patch at the anterior base of the dorsal fin. The base of the coelom nearest the body is black, the ventral surface uncolored; the branchiostegals are clearly marked, dusky against a pale background. The sphenotic, quadrate and posterior mandibular spines are well developed but do not reach the surface of the outer epidermis. The internal vertebral body is of comparatively shallow depth, parallel-sided, with the bases of the vertical fins prominent, with oblique posterior faces. The dorsal and anal have three rays, only two-fifths of which project beyond the outer skin, an amount quite insufficient for any natatory or balancing use. They emerge close to the caudal. The caudal has eight rays, the two outer small and not reaching the full length of the tail.

The basal bone of the illicium is strong, arises from the supra-occipital and extends forward flat on the skull, giving rise, halfway

between the eyes and the snout, to a short, stout, vertical stem. This enlarges into an opaque, roundish bulb, about a quarter of which projects in a large dimple, above the outer skin. From the middle of the throat of the external skin, directly beneath the eye and the posterior end of the gape is an external bulbous swelling about the size of the illicium bulb. This has a notched cap over the summit, and it has no visible tissue connecting with the internal chin or jaw or head. It is unquestionably the anlage of the mental barbel.

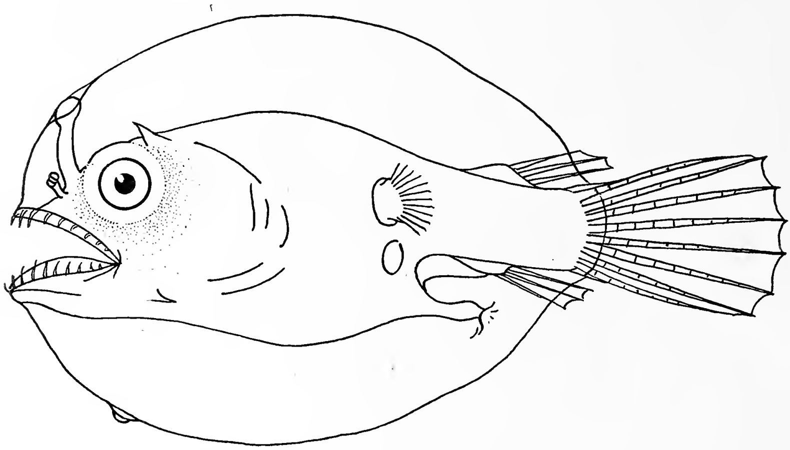


Fig. 24. *Linophryne arborifer* Regan. Post-larva.

Discussion: Owing to the balloon-like, inflated outer skin of this pediculate post-larva, the real fish within has direct contact with the outer world through only fourteen channels, mouth, two eyes, two nostrils, illicium, two gill-openings, anus, two pectorals, dorsal, anal and caudal fins. The remainder of the surface is more or less spongy or rubbery, almost transparent tissue, traversed only by a sparse network of white meandering nerves. The only actually normal sessile organ is the mouth which, as usual, is attached closely to the skull, with, of course, direct open contact with the water. The pneumatic outer skin meets at the lips, making the jaws and teeth usual in appearance. The adaptations of the other points of contact are as follows:

Eyes: In the normal position on the lateral aspect of the skull, but considerably beneath the external skin; contact is made by means of

an absolutely transparent pit, with flaring sides, roofed by thin invisible skin whose presence is revealed only by touch.

Nostrils: Both openings are close together on the summit of tall slender stalks.

Gill Openings: Small and round at the summit of hollow tubes.

Anus: Sinistral, at the end of a long, slender, intestinal tube.

Pectoral: Half of the fleshy base is subdermal.

Dorsal: Three-fifths of the ray lengths are subdermal.

Anal: Three-fifths of the ray lengths are subdermal.

Caudal: One-tenth of the ray lengths is subdermal.

Late Embryo: In net No. 287 there came in the egg of a ceratioid. This is Number 11,509, and was taken July 11, 1929, nine miles south-east of Nonsuch, at a depth of 700 fathoms.

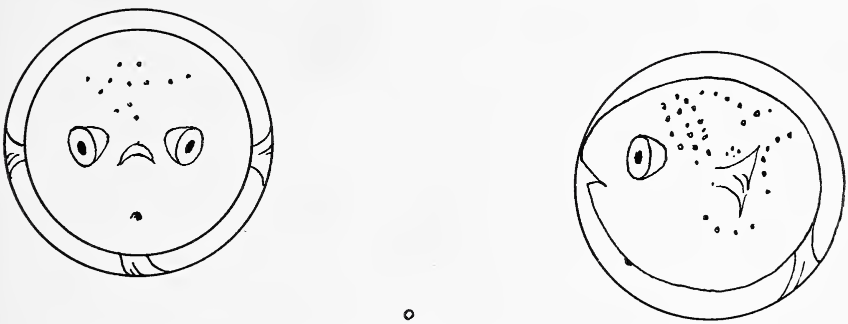


Fig. 25. *Linophryne arborifer* Regan. Late embryo; natural size in center.

The egg was round, 1.3 mm. in diameter and perfectly hyaline. It was almost filled with a fully-developed young ceratioid. The front view shows it in outline as round as the slightly larger egg, with two equally round eyes, directed well forward. It touches the inner wall of the egg shell at three points—the pectorals and caudal. The former are so big that they are bent over at the point of contact, and the tail fin is pushed downward and to one side, all braced hard against the little sphere. The lateral view shows in profile only two contacts—the snout pressed against the egg and the bent and depressed tail fin. I can detect no signs of vertical body fins. The inner, narrow body of the fish is translucent and the outer balloon skin is so thin and transparent that only in certain lights is it visible at all. Its general con-

tour on the head and sides is faintly indicated by a sparse scattering of pale blue chromatophores. There is no sign of an illicium, but the most significant character is a distinct dark spot, resolving into a slight elevation under high power, on the throat. A ceratioid with a mental barbel can be only a *Linophryne,* and so I choose to consider this as the earliest known stage of the only common species, *arborifer,* which we have taken in our hauls.

The points of greatest interest are the large size and forward direction of the eyes, the presence in the egg of the larval balloon skin, and the absence of a free-swimming larval stage. This fish would have hatched in a day or two with perfect post-larval outline, eyes and fins.

Linophryne brevibarbata sp. nov.
(Adult and post-larva)

Type: *Number* 11,656, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 308; *July* 16, 1929; *nine miles southeast of Nonsuch;* 900 *fathoms; standard length* 33 *mm.*

Field Characters: A stout, short-bodied ceratioid, black, with pale buffy fins, illicium and barbel; iris iridescent green; moderate sphenotic and short opercular spines; illicium bulb with short tentacle; barbel with three short, stout branches, each lined with five to eight blunt, finger-like processes, not extensible.

Measurements and Counts: Total length 44 mm.; Standard length 33 mm.; depth 22 (in length 1.5); head 20 (in length 1.65); eye 2 (in head 10); snout 4.8 (in head 4); maxillary 9.3 (in head 2.1); pectoral 16; pectoral length 4.3; caudal 8; caudal length 11; illicium total length 3.5; barbel total length 4.3.

General Description: Body nearly oval, the tail end broader; back and abdomen evenly curved, snout rather stout; eye large, iris brilliant green; nostril openings close together on a rounded tubercle arising on a large, conspicuous mound, on each side of the illicium base, and considerably nearer the tip of the snout than the eye; teeth much broken and worn, about six pairs in the upper jaw and nine or ten in the lower, several forming an irregular second row; the anterior teeth are larger than those behind; a pair of small vomerine teeth; the skin is black and smooth, and has a sparse network of several long, meander-

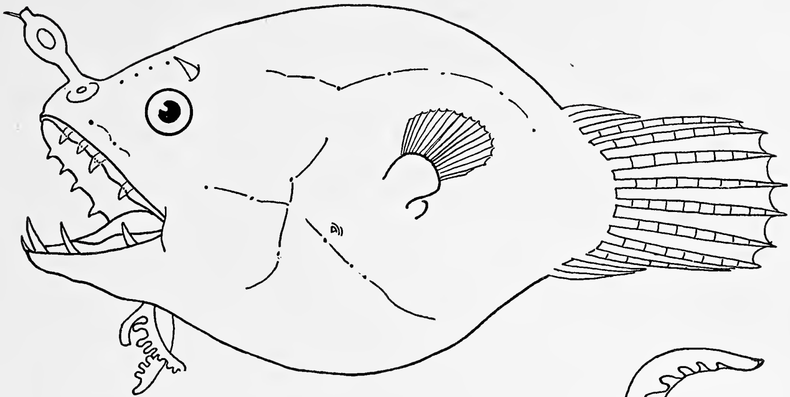
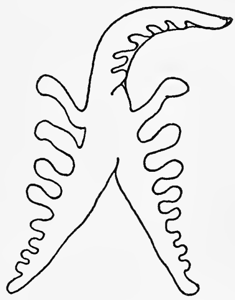


Fig. 26. *Linophryne brevibarbata* sp. nov.



ing, white threads, marked at intervals by round, glandular openings; the moderate sphenotic spine points obliquely forward, the small opercular spine is directly out at right angles to the body.

The dorsal and anal fins project beyond the skin only a short distance, and lie close to the dorsal and ventral base of the caudal; the rays are densely sheathed in thick epidermis; but they seem to number three in each fin; the pectorals of sixteen rays are well-developed, well back and are just above and partly over the gill-openings; the caudal is long and tumid, the eight rays being thickly encased in tissue.

The illicium stem is short and enlarges at once into a largish, oval bulb, translucent with a dark blue, oval core, and slightly frosted at the upper end; beyond this is a short stem which gives off a single anterior tentacle, and two posterior tentacles. The barbel is apparently full-sized, but quite unlike that of any other member of the genus; it consists of three short, stout branches, each lined on one side with five to eight short, thick tentacles, varying from low distal tubercles which grade into finger-like processes.

Post Larva: An immature specimen of this form of *Linophryne* is recorded as Number 18,535; Net 882; taken September 13, 1930; 10 miles South of Nonsuch; depth 700 fathoms; standard length 26.4 mm.

This larva was of the usual balloon-skin type, the outer skin finely vermiculated with dusky, but translucent; the dorsal surface of the inner skin of the head, and the opercular region coarsely dotted with large black chromatophores; an irregular band, several chromatophores broad, along the lower side of the inner vertebral body.

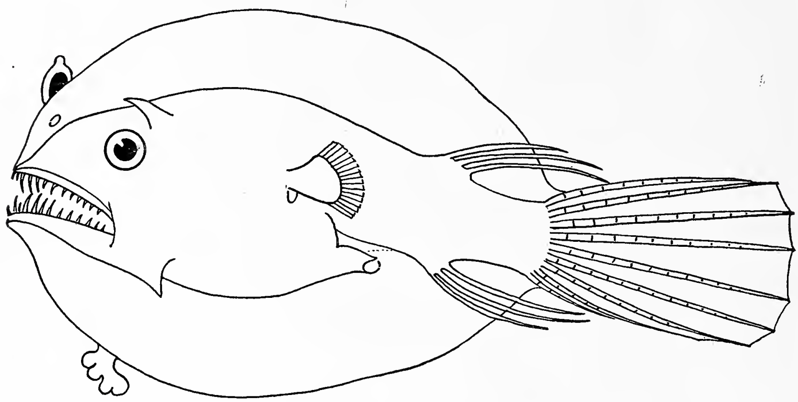


Fig. 27. *Linophryne brevibarbata* sp. nov. Post-larva.

The large bulb with frosted tip appears just above the surface of the skin, the inner blue core very large and conspicuous; a chin barbel shows the general shape of that of the adult, but is short, and with only a suggestion of the tubercles and tentacles; the anus is sinistral, the teeth are fairly even and more numerous than in the older specimen; in one-half of the upper jaw sixteen teeth, three anterior on each side very short and grouped closely together, a longer canine on each of the inner sides of the open symphysis. In a lower half jaw there are eighteen, in graded fives, set obliquely, several of which are probably replacement teeth.

In the cleared and dyed aspect, the vertebrae are seen to be slightly ossified, the jaws and caudal rays very strongly, and the opercular apparatus, the widely separated dorsal cranial bones, and the vertical fin rays with a medium amount of ossification.

Lophodolus lyra sp nov.

Type: *No.* 21,610, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1,111; *July* 27, 1931; *ten miles south of Nonsuch; Depth,* 800 *fathoms; standard length* 47 *mm.*

Field Characters: A small, dark brown ceratioid, with very large mouth and head, small eyes, and numerous teeth of small size. A short, thick illicium bears a dark ball at the tip with a terminal pair of snow-white, lyrate tentacles.

Sphenotic, quadrate, mid and posterior mandibular, and symphysial mandibular spines present. There are six dorsal and five anal rays, only four in each fin projecting above the skin.

Measurements and Counts: Total length 53 mm, standard length 47 mm; depth of head 19.3 (in length 2.4); head 20 (in length 2.4); eye .86 (in head 23.2); snout 5 (in head 4); maxillary 9 (in head 2.2); mandible 13.5 (in head 1.4); pectoral fin 18 rays, length 4.5 mm; dorsal 6; anal 5; caudal 9; illicium basal bone 4.3; stem 5.7; tentacles 4.3 mm.

General Description: The head of this fish is enormous, going into the length two and a third times. The dark brown skin covers all the fin rays. The head is strongly curved above, while the comparatively straight ventral outline is broken by the sharp posterior angle and spine of the mandible. The peduncle is thick and parallel-sided and the tail fin continues the same width.

The eyes are very small, going over twenty-three times into the head, but they are bright and functional; the nostrils are placed in a single, tubular tentacle, half-way between the snout and eye, the two openings placed respectively at the summit and half-way down the posterior side; the mouth is very large, with an enormous gape, and placed at a 35° upward angle.

Teeth: In the maxillary the teeth are very numerous and small; in one-half of the mandible there are about thirty teeth, half of which are twice as long as the rest.

Skin: The skin is smooth, while scattered over the body from snout to tail, in meandering lines, are numerous, small, flattened filaments, each ending in two distinct openings.

Spines: The sphenotic spines are very strong and large, the quadrate small, long and sharp, and the mandibular much shorter; the mandibular symphysis is extended downward into a single, compressed spine, and the infero-posterior angle of this bone is produced into a sharp spine.

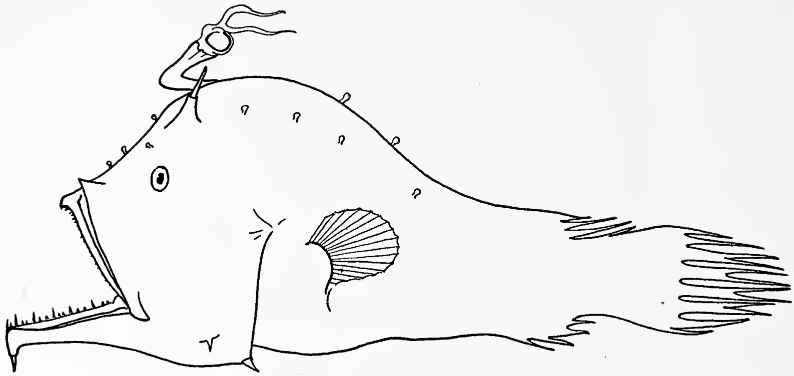


Fig. 28. *Lophodolus lyra* sp. nov.

The pectorals are placed about mid-body, the rays being 18 in number and 4.5 mm in length; there are four dorsal rays visible above the surface of the skin, set rather vertically and at the base of the peduncle; four anal rays, with the slightest suspicion of a fifth are arranged very obliquely along the ventral contour of the body. In several specimens of various ages, cleared and stained, six dorsal and five anal rays are visible, together with their muscular bases well below the surface of the outer skin. The caudal shows nine rays, the four central ones equally branched.

Illicium: This is well-developed but comparatively short and stout. Its total length is 14.3 mm. Much of the basal bone is sunken beneath the surface of the skin or in a deep trough or groove. Only the forward part is free, and elbows almost at once upward into the stem, still covered with the sepia-brown skin pigment. It immediately begins to expand into the transparent sphere which contains a large, opaque, black bulb. The upper third of this is powdered with silky white, forming a distal saddle of a tissue like silver snow, extending down in a short V in front. From this point there extend upward, from the very summit, two long, snow-white, lyrate tentacles, thick at the base, tapering rapidly.

Discussion: This ceratioid is not rare. I have taken about 40 specimens in my limited area of operation, from 600 to 1000 fathoms, more than half being in the 900 and 1000 fathom nets.

Melanocetus murrayi Günther
(Post-larva)

Specimen Number 21,516, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1097; *July* 24, 1931; *ten miles south-west of Nonsuch;* 700 *fathoms; standard length* 9.3 *mm.*

Field Characters: A small, globular, pneumatic-skinned, buffy orange ceratiad, pectorals and caudal well-developed, about half of vertical fins projecting through skin; nostrils large.

Measurements and Counts: Total length 13.5 mm.; Standard length 9.3; depth 7.8 mm. (in length 1.2); depth inner body 5 (into length 1.8); head 5 mm. (in length 1.8); eye 1 mm. (in head 5); snout 1 mm. (in head 5); mandible total length 2.3 mm.; pectoral 15, pectoral length 1.4 mm.; dorsal 13; anal 4; caudal 11.

General Description: The external outline of the fish is almost circular, the outer epidermis coming into contact with the fish itself only at the mouth, nostrils, eyes, anus, illicium and fins. This pneumatic outer skin is transparent white, finely peppered with minute black chromatophores, giving it a pale bluish appearance. The anterior profile of the head is rounded steeply, being slightly broken by slightly protruding lips and the small mouth. The curve of the ventral profile, while almost circular is compressed and ends just in front of the anus. The base of the anal fin is oblique, and that of the caudal is vertical. The dorsal fin rays arise from the beginning of the even dorsal curve.

The inner body proper is rather oblong, opaque and a buffy orange becoming greenish on the head, and with considerable dark markings along the dorsal aspect of the trunk muscle bands and on the posterior abdomen. The smooth surface of the inner body is broken, first by the basal bone of the illicium, slender but distinct, which arises from between the eyes, slopes sharply forward and upward, and when near the outer skin over the vertical of the nostrils, sends a very short branch straight up to a pore on the mid-snout.

The eyes are well-developed, and the iris is bright, shining bluish above, and orange for more than the lower half. They are sunken deeply in the epidermal sockets, a normal condition at this stage, for the outer skin is raised considerably away from this part of the head. The nostrils are unusually large, their depth being slightly more than the diameter of the eye. The vision during this pneumatic stage must be rather limited, and the unexpected size of the nostrils is doubtless

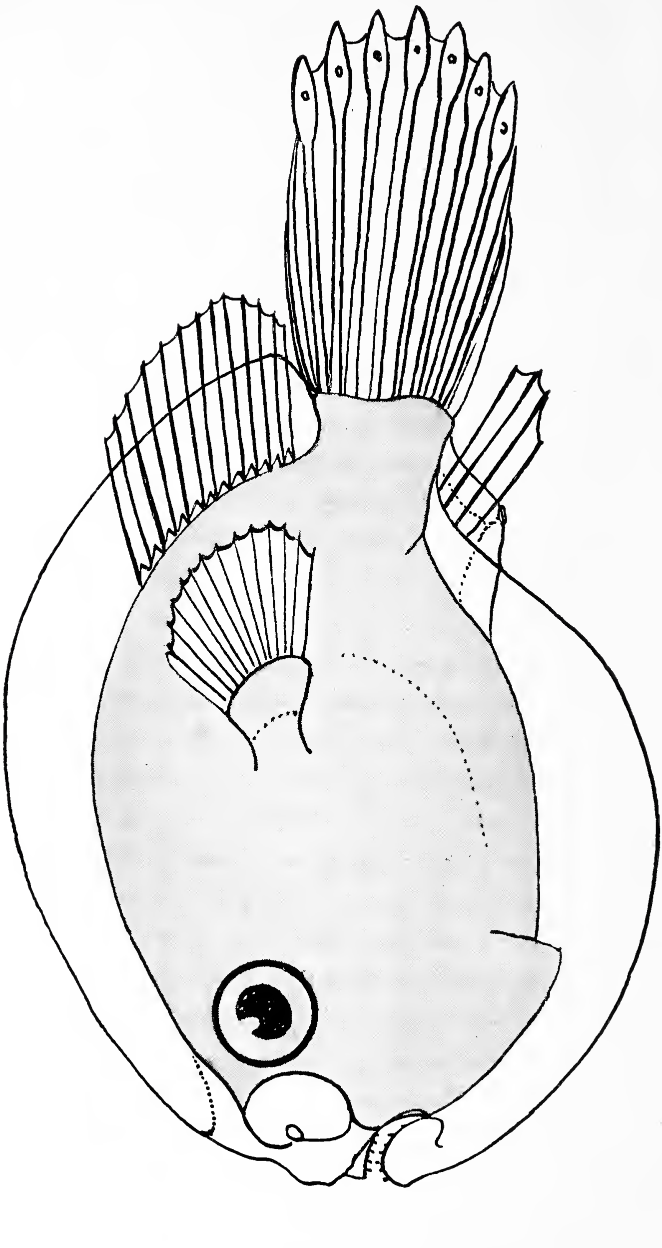


Fig. 29. ***Melanocetus murrayi*** **Günther. Post larva, 9.3 mm. standard length.**

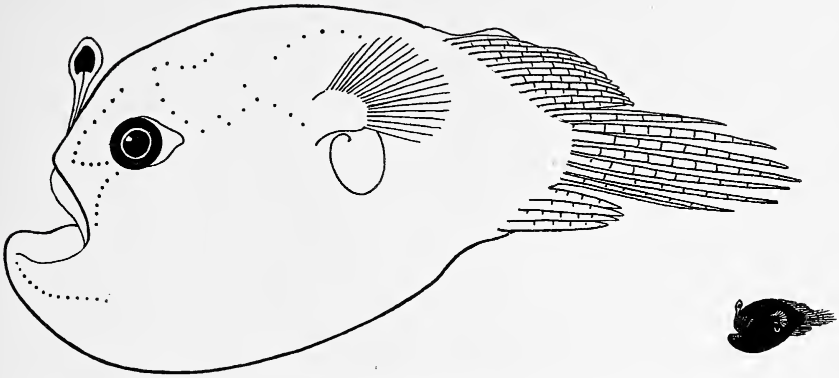


Fig. 30. *Melanocetus murrayi* Günther. Post-larva, 14 mm. standard length.

part compensation for this. The lips are noticeable; on the outside of both the upper and lower lips is a group of small, elevated glands, arranged in minute rosettes. The mouth as far as the aperture is concerned, is small, although the jaw bones are centered far back and down below the profile of the inner body, within the epidermal envelope. The teeth are numerous and minute. The anus is at the summit of a straight intestinal stalk, is median, and placed just before the anal fin.

The dorsal fin has a conspicuous, elevated base, the thirteen rays rising close together, the posterior very close to the caudal. The longest rays are 2.3 mm. long of which about 1 mm. is beyond the outer integument. Even the first protrudes into the open water. There are four anal rays.

Of eleven caudal rays, there are six which are full length, and the tips of these are somewhat spatulate, dead opaque white, with two knots of dark pigment in each. These are slightly but distinctly luminous in the fresh fish, being clearly discernible as a zone of light of indistinguishable color. The tips of the rays of the other vertical fins are whitish and opaque, but no glow was seen. The pectorals are well-developed, about a third of the fleshy base being out of the epidermis.

More commonly taken are specimens about one-third grown, of which No. 18,445 may be taken as a typical example. It came up in net Number 881, on September 12, 1931; ten miles south-east of Nonsuch, from 600 fathoms depth; standard length 14 mm.

The body is brownish black, dead black over the coelom, revealing here and there the dark bluish iridescence over the body cavity. The iris is dark blue with a sparse scattering of silver flecks. The eye socket is pale grey and the downward slant must allow much more of sideways and downward vision than in the adult stage. The illicium stem and bulb are free of the skin, and together measure 2.2 mm. The illicium stem is pale greyish, the bulb dark blue, terminal thickening pale. Nostril leaf tissue pale. The vertical fins dead white, with considerable basal black pigment, which extends a short distance up the rays and ends abruptly. The teeth are very small, scarcely visible above the lips.

Discussion: The ceratioid fish *Melanocetus murrayi* is not uncommon in our Nonsuch hauls. We have taken fifteen specimens up to 117 mm. in total length. Of these there has been a steady increase in numbers from 600 to 1000 fathoms, with June and July as predominant months. One other specimen of post-larva besides that described was taken curiously enough, on July 24, 1929, at 800 fathoms depth, the same depth and exactly two years before the one described above.

The changes from the post-larva to the adult are chiefly increase in size of teeth, complete reduction of pneumatic, dermal envelope, and the development and breaking through the skin of the illicium.

The greatest change in any one organ in ontological development is in the relation of eye to head, which is 5 in the post-larva, 6.4 in the one-third grown, and 24 in the adult.

Aceratias edentula sp. nov.

With notes on *Aceratias* in general.

Type: No. 20,751, *Bermuda Oceanographic Expedition, New York Zoological Society, June* 2, 1931, 1000 *fathoms depth, thirteen miles south-southeast of Nonsuch, Bermuda; Standard length* 19.6 *mm.*

This small, dark Ceratioid differed outwardly in no radical respects from the descriptions of *Aceratias macrorhinus.*

It was brownish-black, except for the lips and nostrils which were white. In standard length it measured 19.6 mm. while the 6.4 mm. of tail fin gave a total length of 25 mm.; the depth 5.7 mm. went into the length 3.4; the head 7.5 mm. into the length 2.6; the eye was 1.3 mm.

in diameter, into the head 5.7; the snout 1.8 mm., into the head 4.2 times.

The dorsal and anal fins each showed the very short tips of two rays, which barely appeared above the skin half-way down the peduncle. The caudal, covered like the rest of the body with black opaque skin, showed six rays. The sphenotic spines are well developed; the nostrils were strongly protuberant and of great size; the eyes were large, well-developed and telescopic, directed obliquely forward. This is the résumé of a careful examination of the fish, less than an hour after capture.

I had the fish cleared and stained at once by Miss Hollister (KOH Number 871), and within a week the opaque dermal pigment had been completely removed with ultra-violet rays, and it was satisfactorily transparent.

The bones showed complete ossification, and the most superficial examination revealed many unexpected characters. The dermal envelope, which was of considerable extent, had become perfectly hyaline, and the real body showed a depth of only 3.5 mm., a new relation to the length of about 6 times.

Instead of two dorsal rays we find six, the tips of four not reaching the external skin, and there are five instead of two anal rays. The six caudal rays visible in the fresh fish now become nine, four above and five below the mid-line. The lowermost takes no stain and is very difficult to see except at the very base where it is faintly pink. There are twenty vertebrae. The sphenotic spines are well developed.

There is a very thin, straight illicial basal bone identical in structure with the one I have described for *Haplophryne hudsonius** even to the presence of the minute particles of bone some distance back from the tip. It extends forward and obliquely upward from its origin in the center of the supraoccipital. The anterior end is flattened laterally and for a long time I could detect no terminal attachment. It seemed to end in mid-tissue. But by careful manipulation of light, a short column of unstained tissue, perhaps pre-cartilage, became clearly visible, extending straight upward and ending in a distinct epidermal pore. I gave the specimen to two of my assistants and in the course of ten minutes both had located and identified the entire illicium structure—

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the basal bone with its complex musculature, the slender colorless vertical stem and the open pore at the surface of the epidermis. The latter was quite invisible in the fresh specimen. The musculature (four pairs at least) of the basal bone is as powerful as in fish with an elaborate, free illicium which can be moved back and forth.

Parenthetically may I add that if the clearing and staining is done carefully and with constant readjustment to the type of fish, whether solid or flabby-fleshed, scaled or naked, structures such as the various body organs, cartilage, illicium stems, bulbs and pores are extremely easy to detect and to differentiate in great detail. Osseous tissue is only the more deeply stained and the more obvious of the bodily structures.

In this species at least, if not in the genus as well, this illicium stem, arising at the anterior tip of the basal bone, completely negatives the idea that the rostral denticle has anything to do with a vanished, anterior dorsal ray. When Parr propounded this idea I welcomed it gladly as accounting for the troublesome, new osseous structure at the tip of the upper jaw, but in *Aceratias* it seems we must look for some other explanation.

The superior rostral denticles are strongly developed, a median and two, lateral, large, curved fangs firmly implanted in a basal bony shield —shaped like a convex triangle with a deep curved bay between the two lower points. It has no close connection with any bone and only a very slight one with the rostral cartilage.

There is a remarkably radical modification of the upper jaw proper. The premaxillaries are closely opposed along the median line in a pronounced symphysis, but send out only very short, slender, lateral arms. In size, position and shape they resemble the premaxillaries of fish wholly unrelated to a Pediculate. The maxillaries are reduced to slender rods of bone which rise outside the mandible, about four-fifths of the distance to the quadrate, extend forward to within a fourth from the mandibular symphysis, and there end in short, two-pronged forks, the inner of which connects with the lateral arms of the premaxillaries. The upper jaw is therefore much shorter than the lower and modified out of all normal proportions.

The mandible is strong, deep and perfectly developed. It bears no teeth but has irregular nicks and two fairly deep scallops in the rim.

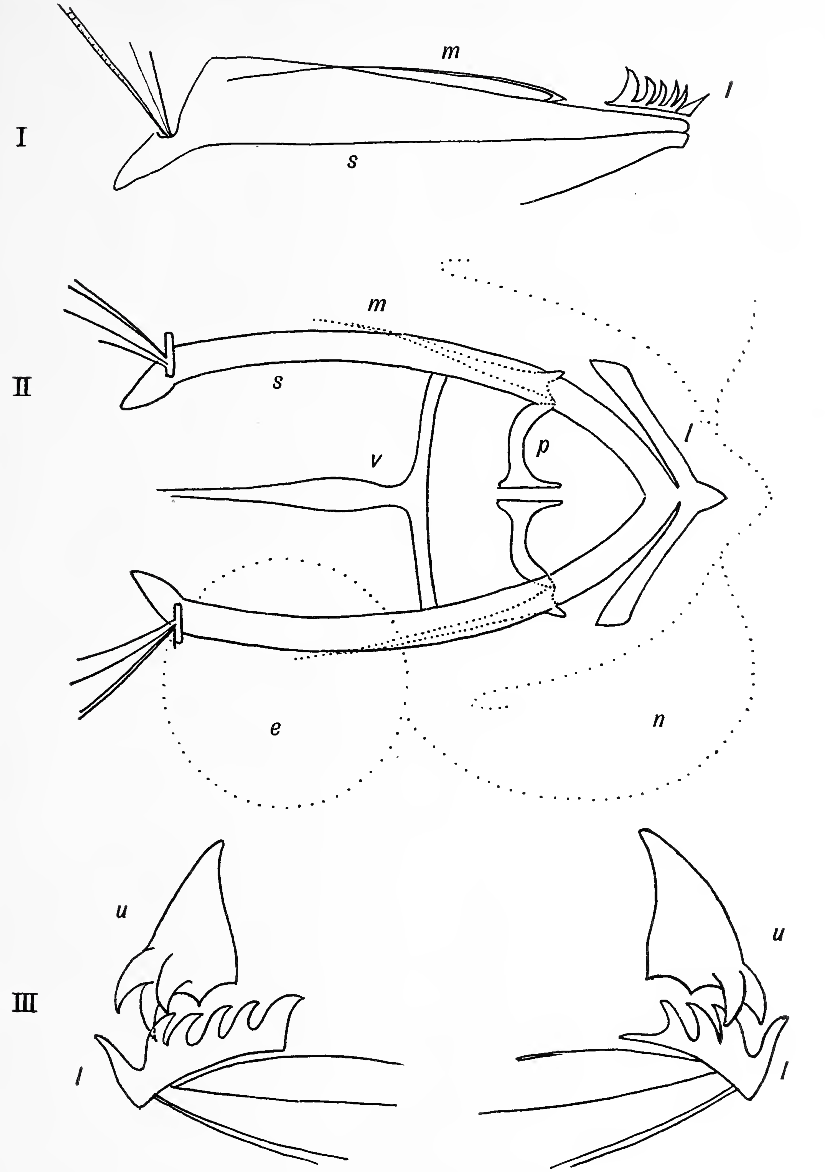

Fig. 31. *Aceratias edentula* sp. nov. Jaws.
I. Lateral view; II. Upper view; III. Right and left lateral views of rostral denticles.
u. Superior rostral denticles. l. Inferior rostral denticles. m. Maxillary. p. Premaxillary.
s. Mandible v. Vomer.

These latter fit into corresponding but much shallower curves in the maxillary. Arched over the anterior part of the mandible, and extending a considerable distance back of the symphysis is a large, angled bone, a solid base from which spring nine strong fangs, all sharp and curved, except the median one which extends straight upward. The central ones interlock with the superior rostral denticles. This bone with its nine teeth is quite free from the mandible even at the symphysis where they approach closest. Curiously enough this bone while quite unbroken and thoroughly ossified, is asymmetrical. It is slightly longer on the left side where it bears five teeth, than on the right which bears only three curved fangs. This bone, while it offers no absolute proof of the origin of the superior denticles, yet obviates the necessity of accounting for them by a connection with the dorsal rays, for there is no possibility of calling on the anal fin to perform a similar service for the mandibular denticle plate.

When we remember the astonishing spines, barbules, tentacles, photophore organs and scales in this order of fishes, the independent appearance of a pair of osseus plates is not unreasonable—structures doubtless intended to subserve some highly specialized function.

To check up on all the above details I have re-examined specimen Number 15,867, taken in Net Number 689, on June 9, 1930, at a depth of 1000 fathoms. It had a standard length of 15.8 mm., with a total of 24.3 mm. In the presence and development of the basal bone, illicium stem and epidermal pore it offered no differences. The jaws too were edentulous except for a solitary tooth on the mid-right mandibular ramus, very weakly developed. The remainder of the mandibles showed slight rugosities. The degenerate upper jaw was like the larger specimen. The two rostral denticle ossifications are so much like those of the other fish that they even share asymmetry. The three large fangs in the upper plate do not radiate evenly, but are turned, one to the right and two to the left. The mandibular plate has three teeth on the right and five on the left, exactly like that of the other specimen. Here again we are forced to the conclusion that those two structures have originated independently of any preceeding organ, and cannot be correlated with any definite structure in other groups of fish.

The suggestion of Parr seems very probable that these small Aceratiids are the free-swimming males which, according to Regan's

astonishing discoveries, sooner or later attach themselves, parasite-like, to much larger females. It is likely that not all the subsequent degeneration of osseous and visceral tissues takes place after the growing together of the two sexes. With this possibility, any hard and fast classification based on ordinary organs becomes a difficult matter. For example, according to the latest diagnostic table my specimens Number 20,571 and 15,867 line up as follows:

Telescopic eyes	
Enormous nostrils	
Sphenotic spines	Aceratias
Closed jaws	
Sub-dermal vertical fins	
Edentulous jaws	Rhynchoceratias

Other minor characters could be added, but these are sufficient to show how one or two additional specimens can upset preconceived ideas. I feel that any detailed view as to the evolution and exact relationships of these abyssal fish should wait for the examination of hundreds instead of individuals. Rather however than confuse the ultimate issue by assuming an amazing variation in a single species, I have chosen to reject the edentulous jaw condition as chief generic differentiation, and recognize the extremely degenerate upper jaw, etc., as of specific value.

Aceratias edentula differs from *macrorhinus* as described by Brauer in various proportions; the depth being slightly less, the head larger, the eye and the snout considerably smaller. The differences in dorsal and anal fin count is due probably to the subdermal character of these organs. *Edentula,* unlike *macrorhinus,* lacks all regular teeth on maxillary and mandible, and has the upper jaw degenerate, if not atavistic, while the rostral denticles and plates are strongly developed, three fangs on the upper and nine on the asymmetrical lower.

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VOLUME XIII. NUMBER 5

NEW BERMUDA FISH,

Including Six New Species and Forty-three Species Hitherto Unrecorded from Bermuda

By William Beebe and
John Tee-Van

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NEW BERMUDA FISH,

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BY WILLIAM BEEBE AND
JOHN TEE-VAN

During the three seasons' work (1929, 1930 and 1931) of the Department of Tropical Research of the New York Zoological Society at Nonsuch Island, Bermuda, the following species of apparently undescribed shore fish were taken, all within a radius of two miles of the island. The type specimens are in the collections of the Department of Tropical Research. Illustrations of these forms will be given in forthcoming publications on the fishes of Bermuda.

LIST OF SPECIES

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* Contribution, Department of Tropical Research, New York Zoological Society, No. 368.

Quassiremus goslingi sp. nov.

Type: No. 8700, *Bermuda Oceanographic Expedition, New York Zoological Society, Captured with hand line at 30 feet depth, Castle Roads, Bermuda, March* 21, 1929, *Length* 652 *mm.; Paratypes:* 2 *specimens,* Nos. 25,150, (623 mm.) *and* 25,151 (710 mm.), *captured at same time and place.*

Field Characters: Elongate, cylindrical, firmly-built eels with tip of tail forming a hard point, the dorsal and anal fins ending before the tail tip; pectoral fins rudimentary, visible as a minute flap immediately back of the gill-opening. Brownish with conspicuous dark brown, orange and red spots, pale below.

Measurements and Counts: (Type) Length 652 mm.; trunk plus head 361 (1.8 in length); trunk 304 (2.14 in length); tail 291 (2.2 in length); depth 24 (27 in length); width of body 23.5 (27.7 in length); snout to dorsal fin 74.5 (8.7 in length); head 57 (11.4 in length); eye 5.6 (10 in head); interorbital 7.8 (7.3 in head); snout 12.5 (4.5 in head); snout to gape 21 (2.7 in head); width at gape 13 (4.38 in head); pectoral length 1 (57 in head); length of pectoral base 3.8 (15 in head); gill-opening 6 (9.5 in head).

Description: Body elongate, cylindrical, flattened slightly on the ventral surfaces, the tail tapering from the anus to its tip, ending in a stiff hard point. Depth and width of body almost equal, the depth of the body 2.25 to 2.5 in the head.

Lateral line beginning on the head above the gill-opening, continued along the middle of the sides, consisting of approximately 125 well-marked pores.

Head tapering anteriorly, the sides flattened, the region of the gill-covers somewhat swollen. Snout tapering, its dorsal view abruptly rounded anteriorly, the snout extending about one-half an eye's diameter beyond the tip of the lower jaw.

Eye 10 to 11.3 in the head, 2.3 to 2.5 in the snout, elliptical, its long axis horizontal, the upper margin reaching the dorsal profile, its outer transparent lid continuous with the skin of the head.

Anterior nostril in a short, downward-pointing tube not quite at the tip of the snout. Posterior nostril aperture almost as large as the anterior, rounded, situated within the upper lip just below the anterior end of the eye, concealed by a dermal flap which begins just anterior to the nostril.

Mouth medium in size, the jaws straight and closing completely, the gape extending half an eye's diameter beyond the eye.

Teeth conical, pointing backward. Two or three large, curved teeth at the anterior part of the jaw, maxillary with 12 to 14 teeth on each side. Mandible with 13 to 14 teeth in a single row on each side. Vomerine teeth in a single row, 14 in number, the anterior 5 much larger than the others.

Gill-openings small, their openings slightly greater than the eye's diameter, situated on the lower sides, almost vertical, the distance between them, ventrally, equal to about twice the length of the slit.

Dorsal fin depressible in a deep groove, its supporting rays rather high, their height more than half the depth of the body. Anal fin similar to the dorsal in height.

Pectoral fins minute, represented by a dermal flap at the upper end of the gill-opening, their base about one half the length of the gill opening.

Color in life: General color of sides above the lateral line salmon-buff, changing abruptly beneath the lateral line to creamy white. Seventeen saddle-like markings of salmon-orange along the dorsal surface, these spots becoming darker centrally, this darkening most pronounced on the three last markings. A series of large light orange spots which shade to deep chrome in the center, on the mid-sides, one between each of the saddle-like markings. Between the upper saddles and the lateral spots are smaller, similarly-colored spots, the majority with dark centers. Snout with a pinkish buff background and with small irregular blackish spots. Back of the eye these spots enlarge and change to antique brown. Iris pale gold with dark markings anteriorly and posteriorly. Lateral line pores white, conspicuous from head to tail. Dorsal fin marked with pale orange spots, somewhat like those on the body, the fin margined with white. Anal fin transparent, with a few orange spots posteriorly.

Discussion: The only previously recorded species of *Quassiremus* from the Atlantic is *Quassiremus productus*, described by Seale in 1917 from the Bahama Islands, as the result of a specimen taken in 1861. The present species differs from *productus* in the following particulars:—smaller mouth, the distance from the snout to gape 2.7 to 3.1 in the head as opposed to 2.3 in *productus;* the posterior nostril is a rounded hole, not a slit; eye 2.1 to 2.5 in the snout, not 1.7 as in *productus;* pores of the lateral line prominent; dorsal and anal fins high; somewhat different color pattern.

Name: We take pleasure in naming this remarkable new eel for the Honourable F. Goodwin Gosling, to whom we owe the first suggestion of using Nonsuch as a scientific station, and whose kindness in Bermuda, to visiting scientists, has become proverbial.

Exonautes nonsuchae sp. nov.

Type: No. 9983, *Department of Tropical Research, New York Zoological Society, in Sargassum weed near shore of St. David's Island, Bermuda, May* 15, 1929, *Standard length* 24.5 mm.

Field Characters: Very small, four-winged flyingfish without jaw barbels, and with 13 anal rays. Pinkish above with vertical orange cross-bars on the sides. Tips of pectorals and ventrals bright orange, the base of each fin with a dark black or blue spot. Tips of dorsal and anal fins orange.

Measurements and Counts: Length, total 30.3 mm.; length, standard 24.5 mm.; depth 3.8 (6.4 in length); width of body at gill-openings 3.8; head 5.8 (4.2 in length); eye 2.4 (2.4 in head); interorbital 2.4 (2.4 in head); snout 1.2 (4.8 in head); snout to pectoral origin 5.3; snout to ventral origin 13; snout to dorsal origin 15.5; snout to anal fin 16.5; length dorsal base 5.2; length of longest dorsal ray 4.1; length anal base 4.5; length longest anal ray 3.5; length lower caudal lobe 7.5; dorsal fin 12 rays; anal 13 rays; 49 scales in a lateral series.

Description: Rather elongate, the profile from eye to origin of dorsal fin straight, the anterior portion of the dorsal fin base raised; head from snout to above posterior portion of eye straight, but at a considerable angle from the back; snout short, pointed when viewed either from the side or above; eye large, circular, entering the upper profile; mouth small, oblique; maxillary small, almost vertical, its posterior margin reaching to the anterior margin of the eye.

Dorsal fin high anteriorly, becoming considerably shorter posteriorly; anal fin similar but not as markedly so, the latter fin beginning beneath the 2nd and 3rd dorsal ray. Pectoral fin with 18 rays, the first two parallel and very close together, the anterior slightly shorter than the second and simple, the second ray branched; 6th and 7th rays longest, the 5th and 8th equal in length, the 3rd, 4th and 5th becoming progressively longer in almost equal amounts; the adpressed pectoral fin reaches to next to the last ray of the

dorsal fin. Ventral fins prominent, the tip of the adpressed fin reaching slightly beyond the anal base.

Color: (See Frontispiece of "Nonsuch; Land of Water" for color plate). In life,—general color of body somewhat pinkish with six vertical orange bands on the sides, the posterior one below the posterior tip of the dorsal fin. Posterior portion of caudal peduncle dark blue. Upper parts with small scattered bluish chromatophores. Dorsal fin orange superiorly with a small dusky spot at the tip. Anal fin orange distally, with a blackish tip. Caudal fin colorless. Pectoral fin bluish-black at base, its anterior outer portion bright orange, with scattered black chromatophores along the rays and along the margin of the fin; a small dusky spot in the center of the fin near the orange portion. Ventral fins with a blackish spot at their base, in the center of which is an orange spot; distal $\frac{3}{5}$ of ventral fins bright orange with dusky toward the tip of the rays.

In preservative the entire body is dusky blue-gray. Vertical fins slightly dusky, the anterior tip of the dorsal with a dusky patch. Pectorals transparent with the exception of a dusky patch at the base and an irregular patch of dusky along the anterior edges, this patch widest and most prominent at the outer tip of the fin. Ventral fins dusky at base and on outer $\frac{3}{5}$ of the fin, the remainder transparent.

Discussion: The present species does not answer the descriptions of any of the Atlantic flyingfishes sufficiently well to assign it to any definite form. Until its relationship to some adult form can be established, it seems best to give the present specimen a new name.

It is of interest that this species, as well as *Cypselurus furcatus* and other young of *Exonautes* which live in Sargassum weed, should all possess a broken and mottled wing-pattern.

Corythoichthys bermudensis sp. nov.

Type: Male, No. 9326, *Bermuda Oceanographic Expedition, New York Zoological Society, Nonsuch Island, Bermuda,* August 18, 1930, *standard length* 61 mm.

Field Characters: Small, rather short and robust pipefish with upturned snout and dorsal fin of 23 rays on 0 body and 7 caudal segments; 17 body and 26 caudal segments; greenish-brown, somewhat mottled and with vertical, irregular lighter patches.

Measurements and Counts: Length, total 64 mm.; length, standard 61 mm.; head and trunk 26.5 mm. (2.3 in length); tail 34.5 (1.77 in length); depth 3.8 (16 in length); head 6.5 (9.4 in length); snout 2.1 (3.1 in head); eye 1.2 (5.4 in head); post-orbital head 3.3 (1.97 in head); snout to origin of dorsal fin 27; pectoral length 1.6; caudal fin length 3; dorsal fin 23 rays on O plus 7 segments; pectoral 11 rays; caudal 9 rays; body segments 17, caudal segments 26.

Description: Snout short, upturned, with a slight median crest which ends between the orbits; after a short space this crest begins again and ends on the nape. A small supra-orbital ridge, and a small but well-developed ridge on the opercle, from which small striations radiate downward and backward. All of these ridges are smooth and not serrated.

Superior trunk crests end just before the posterior end of the dorsal fin; median lateral trunk crest ends on the last body segment, slightly below the middle of the sides, with no indication of any attempt to join the lower body ridges. Superior caudal crest begins on the last body segment, below the superior trunk ridge and roughly paralleling it until the caudal ridge ascends to its position on the caudal portion of the body. Inferior trunk and caudal crests continuous. Dermal appendages not present.

Brood pouch extending on 15 caudal segments, its dermal flaps not meeting on the mid-ventral line.

Color: Body mottled greenish brown, the lower surface of the trunk greenish; dull yellowish, irregularly margined vertical bands on the body and trunk,—about 8 on the trunk, these conspicuous mostly on the dorsal half of the sides, about 9 on the tail, these widest on the upper half of the sides; a series of small brownish spots on the keels of the tail. Upper surface of the head and cheeks greenish brown, the lower surface of the head and snout yellowish. A brown line on the snout from eye to angle of mouth. Dorsal fin with small brown spots on the rays.

Discussion: In Parr's key (1927, p. 30) to western Atlantic *Corythoichthys*, this species is closest to *C. cayorum* Evermann and Kendall 1897. It differs from the latter in various counts and proportions, and when compared with the original plate of *cayorum*, markedly in the lesser size of the head ridges.

Syngnathus pipulus sp. nov.

Type: No. 25,152, *Bermuda Oceanographic Expedition, New York Zoological Society, The Reach, Bermuda, October* 25, 1931, *Standard length* 113 mm.

Field Characters: Pipefish with short tail (26 caudal segments); short dorsal fin of 22 rays on 1 body and 4½ caudal segments; yellowish buff mottled with greenish.

Measurements and Counts: Length, total 116.5 mm.; length, standard 113 mm.; head and trunk 52.5 (2.15 in length); tail 60.5 (1.87 in length); depth 5.5 (20.5 in length); head 15.2 (7.4 in length); snout 7.4 (2.05 in head); eye 2.3 (6.6 in head); post-orbital head 6 (2.5 in head); snout to dorsal origin 49.5; pectoral fin length 2.5; caudal length 3.5; body segments 18; caudal segments 26; dorsal fin with 22 rays on 1 body and 4½ caudal segments; pectoral rays 13; caudal rays 7.

Description: Snout rather long with a low serrated ridge extending from about ⅓ the distance from the snout to the eyes, and ending at the anterior margin of the orbits. A slightly serrated ridge on the nape. Supraorbital ridge extending slightly back of eye.

Superior body ridge ending on the 4th caudal segment. Superior caudal ridge beginning on the last body segment; median lateral body ridge ending on middle of sides of last body segment. Inferior trunk and caudal ridges continuous. Head and body with small dermal tentacles, especially prominent on the body ridges.

Marsupium extending on 20 caudal segments, containing eggs.

Color: (Preserved specimen) General color dull yellowish buff, the sides and upper parts mottled with brownish. Narrow transverse bars of pale dull yellow on the upper surfaces and vertical bars of the same color on the sides,—4 on the body segments and 9 on the caudal. Under surfaces, especially the caudal portion of the body, with transverse brownish-green bands. Snout mottled with brown. Fins colorless.

Eucinostomus mowbrayi sp. nov.

Type: No. 9328, *Bermuda Oceanographic Expedition, New York Zoological Society, Nonsuch Island, Bermuda, September* 30, 1930, *standard length* 140 mm.

Field Characters: Small, somewhat elongate, compressed,

bright silvery fishes with extremely protractile mouth parts; third anal spine twice as large in diameter as the second and slightly longer; first anal spine very small.

Measurements and Counts: Length, total 168 mm.; length, standard 140 mm.; depth 47 (2.98 in length); width of body 20 mm.; head 41.5 (3.4 in length); eye 14.2 (2.9 in head); snout 14 (2.96 in head); maxillary 14 (2.96 in head); interorbital 12 (3.46 in head); pectoral fin length 29 (1.4 in head, 4.8 in length); snout to dorsal fin 52; length of interhaemal spine 22; dorsal IX, 10; anal III, 7; gillrakers 7, the lowermost slightly longer than the uppermost; scales, 48 rows, 4½ rows from origin of dorsal fin to lateral line.

Description:—Body elongate, compressed, back moderately elevated; anterior profile slightly convex from snout to occiput, and again slightly convex from occiput to dorsal origin; eye large, the interorbital space slightly convex; maxillary reaching slightly beyond the anterior margin of the eye; premaxillary groove linear, widest anteriorly, not crossed by scales; preorbital and preopercle entire; gill-rakers small, 7 below the angle on the first arch, the lowermost slightly longer than the uppermost; lateral line complete, paralleling the back.

Dorsal spines weak, the fin highest anteriorly, the 2nd and 3rd spines subequal and longest, the spines becoming progressively shorter posteriorly; dorsal rays low; a sheath of scales along the base of both spinous and soft dorsal. Anal fin low; first anal spine very short; third anal spine twice as large in diameter as the second and slightly longer; a broad sheath of scales along the base. Pectoral fin not quite reaching the vent. Ventrals with a large axillary scale, their tips not reaching the vent. Caudal fin deeply forked.

Interhaemal spine similar to illustration given by Parr (1930) of *Eucinostomus havana* (Nichols), the air bladder entering a cup-shaped depression in the lower anterior side of the interhaemal spine.

Color: Silvery, darker above, no traces of cross-bars; a dusky spot at the tip of the anterior rays of the dorsal fin. Fins, except the clear pectorals, slightly dusky.

Discussion: This species is close to *Eucinostomus havana* (Nichols), but differs markedly in the relative sizes of the anal spines.

Name: Named for Mr. Louis L. Mowbray, the capable Director of the Bermuda Aquarium, who has shown us many kindnesses in the course of our work in Bermuda.

Iridio bathyphilus sp. nov.

Type: No. 9050, *Bermuda Oceanographic Expedition, New York Zoological Society, taken in trap set in 510 feet water, one mile south of Nonsuch Island, Bermuda, September* 30, 1929, *standard length* 145 *mm.; Paratypes,*—3 *specimens,* Nos. 25,045 *a*, *b* and *c*, 123, 121 and 89 mm. *respectively, taken at same time and place.*

Field Characters: Small, elongate wrasse from deep water with the posterior margin of the caudal fin double-concave. Brilliant in coloration with a band of green or yellow from snout to eye, which bifurcates posterior to eye, the upper bifurcation extending to the nape, the lower continued along the sides as a broken band of yellow, the yellow alternating on two scale rows. A large black or brilliant turquoise-green patch on the upper anterior sides, and sometimes with a small black patch on the body at the base of the middle caudal rays.

Measurements and Counts: length, total 165 mm.; length, standard 145 mm.; depth 34 (4.25 in length); width of body 16 (9 in length); Snout to dorsal fin 37 (3.9 in length); snout to anal fin 72 (2 in length); head, to tip of opercular flap 43.5 (3.3 in length); eye 7.2 (6 in head); interorbital space 9 (4.8 in head); snout 14.5 (3 in head); snout to gape 10.5 (4.15 in head); caudal peduncle height 16.3 (2.75 in head); dorsal fin rays IX, 11; anal fin rays III, 12; pectoral fin rays 13; length upper margin of pectoral fin 23.5; length lower margin of pectoral 10.2; ventral fin rays I, 5; length of ventral fin 21.5; length inner margin of ventral fin 10.7; scales, from upper angle of gill opening 28 to 29; gill-rakers 11 on lower half of the anterior arch.

Description: Body elongate, compressed, the caudal peduncle rather deep; ventral outline almost straight, curved upward slightly near the chin; dorsal outline considerably more convex than the lower. Anterior profile from snout to origin of the dorsal fin a gentle continuous curve. Head naked, medium in size, considerably compressed, the opercle ending in an obtuse fleshy flap above the pectoral fin. Gill membranes attached to the isthmus, only a small part of the posterior portion of the membrane free. Snout obtusely conical, the mouth terminal and horizontal, the gape reaching about two-thirds the distance from snout to eye. Lips full, with internal dermal folds. Anterior nostril with a short tube. Eye elliptical, its long axis horizontal, well below the upper profile and situated somewhat before the mid-length of the head.

Teeth;—Canines $^2/_4$, the upper canines slightly larger than the lower; teeth of the upper jaw becoming progressively larger as they progress forward, so that the teeth next to the canines are large, but are not likely to be confused as a second set of canines. A conspicuous posterior canine on each side.

Scales in 28 or 29 rows, rather large; 2½ rows between the origin of the dorsal fin and the lateral line, 1½ rows between the lateral line and the middle of the dorsal fin base. Scales of the nape becoming smaller before the dorsal fin, about six rows before the dorsal, the anterior ones difficult to observe, the rows not quite meeting across the nape. Scales on breast small.

Lateral line continuous, curved abruptly downward posteriorly, the straight portion found posteriorly on six scales only; lateral line pores simple, formed of a single canal and pore on each scale, the canal turned upward posteriorly on most of the scales.

Dorsal fin long, the first three spines becoming progressively longer, the remainder of the spines subequal and slightly longer than the third; rays more or less equal in height, higher than the spines. Membrane between spines of the dorsal continuing beyond the tip of the spines. Anal fin rays shorter than those of the dorsal, more or less equal in height; the spines weak and small. Pectoral fin base oblique, the tips of the rays not quite reaching the vent. Ventral fins originate under the posterior base of the pectorals, not reaching the vent, the longest rays somewhat filamentous. Caudal fin biconcave, the central rays as long as the outer ones.

Coloration: In life, middle of sides rich pinkish-lilac (Thulite pink of Ridgway); upper sides duller and each scale with a rich green edge; lower sides yellow and under surfaces white. Top of head and upper lip spinel pink, the lower portion of the head becoming first violet and then greenish blue. A broad viridine green band from snout to eye, broadest near the eye. Two similarly colored bands, the first from the eye to the shoulder, the second from the eye to the upper end of the preopercle. This second band is continued down the side of the fish, continuous and unbroken on the opercle, but zigzag and broken on the body,—found on alternate scales of two adjoining rows. On the upper anterior side is a rich deep turquoise spot, in shape much like two balls pressed closely together.

Dorsal fin pale blue with a pale yellow base and outer margin. Anal fin bright yellow with a blue margin and a narrow reddish-

orange band near to and paralleling the base. Pectoral fins clear translucent. Ventral fins pale blue. Caudal fin pale blue, its upper and lower margins greenish yellow, and with a blue and yellow pattern mesially as follows,—a narrow band of pale blue starting at the upper base of the fin and running to the tip of the middle rays of the caudal where it meets its fellow from the lower base of the fin; two narrower bands of similar blue inside of these, roughly paralleling them; bordering and surrounding these bands the color is bright yellow.

In one of the smaller cotypes, the pattern is similar but the general coloration of the sides is reddish pink. In this example the upper sides are reddish and the middle of the sides pink, while the yellow of the lower sides is concentrated into a band. In addition, there is a small black spot at the base of the caudal, and the central oblique bands on the caudal are lacking.

In preservative the general color is light buff, traces of the color pattern remaining with the exception of the band along the middle of the sides. This has disappeared in all of the specimens.

In addition to the species given above, the following have been added to the shore fish fauna of Bermuda. A number of these species are fairly well known to some of the Bermuda fishermen, but they are apparently unrecorded in the ichthyological literature of the island. *Pneumatophorus colias,* recorded many years ago from Bermuda but ignored by later students, is reëstablished as a Bermuda fish, on the basis of a specimen taken by us in St. Georges Harbour.

Amphioxides pelagicus Günther
Mustelus mustelus (Linnaeus)
Galeocerdo arcticus (Faber)
Carcharias falciformis Bibron
Prionace glauca (Linnaeus)
Myrophis dolichorhynchus Parr
Myrophis platyrhynchus Breder
Chilorhinus suensonii Lütken
Sphagebranchus ophioneus Evermann and Marsh
Myrichthys oculatus Kaup
Aphthalmichthys mayeri Silvester
Gymnothorax polygonius Poey
Gymnothorax albimentis (Evermann and Marsh)
Halocypselus obtusirostris (Günther)

Cypselurus heterurus (Rafinesque)
Bregmaceros macclellandi Thompson
Etropus rimosus Goode and Bean
Pneumatophorus colias (Gmelin)
Peprilus paru (Linnaeus)
Chloroscombrus chrysurus (Linnaeus)
Argyreiosus vomer (Linnaeus)
Astrapogon stellatus (Cope)
Epinephelus mystacinus (Poey)
Trisotropis dimidiatus (Poey)
Gramma hemicrysos Mowbray
Rypticus saponaceus (Bloch and Schneider)
Etelis oculatus (Cuvier and Valenciennes)
Inermia vittata Poey
Eucinostomus havana (Nichols)
Chaetodon sedentarius Poey
Clepticus parrae (Bloch and Schneider)
Xyrichthys splendens Castelnau
Scarus punctulatus Cuvier and Valenciennes
Sparisoma squalidum (Poey)
Sparisoma brachiale (Poey)
Eviota personata Jordan and Thompson
Lophogobius pallidus Parr
Gobius boleosoma Jordan and Gilbert
Gobiosoma longum Nichols
Callionymus boekei Metzelaar
Callionymus dubiosus Parr
Balistes forcipatus Gmelin
Xanthichthys ringens Linnaeus

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ONTOLOGICAL NOTES ON *REMORA REMORA*

BY WILLIAM BEEBE

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ONTOLOGICAL NOTES ON *REMORA REMORA*

By William Beebe

(Figs. 32 to 37 incl.)

Outline

I. Organic Functional Change.

II. Comparison of two Remoras—

One 15 mm. and the other 88 mm. standard length

- Cephalic Sucking Disk.
- Labial Suckers.
- Teeth.
- Scales.
- Fins.
- General Proportions of Growth.

An extremely interesting as well as mysterious phase of organic, and for that matter any other kind of evolution, is not the perfect end products that we see performing their work so smoothly today, but the beginnings, the first hints of organs and structures, of functions and habits.

The most air-minded lizard which ever existed could never have become a creature of flight by launching out from trees and trusting solely to the scales on his fore-legs to fray out ultimately into wing feathers. Time after time I have seen five-foot iguanas leap into midair and when they landed in low scrub it was always their heavy hind-quarters and tail which struck first. Many years ago at the Zoological Park a pin-feathered squab gave me a hint, and from the amazingly well-developed feathers on the outside of its upper legs I turned elsewhere for additional proof and found it in the nestlings of many other birds and in the femoral wing of Archaeopteryx itself. Hence my theoretical Tetrapteryx which serves logically to bridge the first difficult beginnings in the transition from volplaning lizard to volant bird.[1]

[1] A Tetrapteryx Stage in the Ancestry of Birds, Zoologica II, No. 2, 1915.

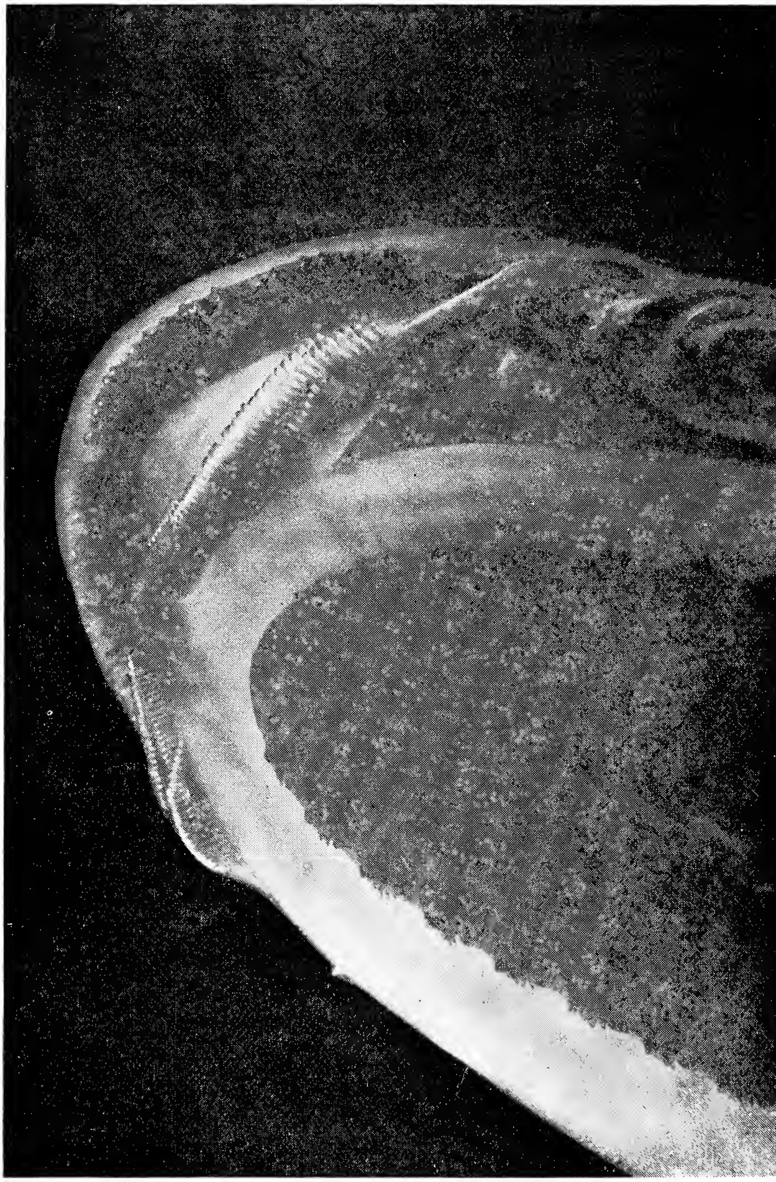

Fig. 32. *Remora remora*, 88 mm. Photograph of dorsal view of head showing functional sucking disk and teeth.

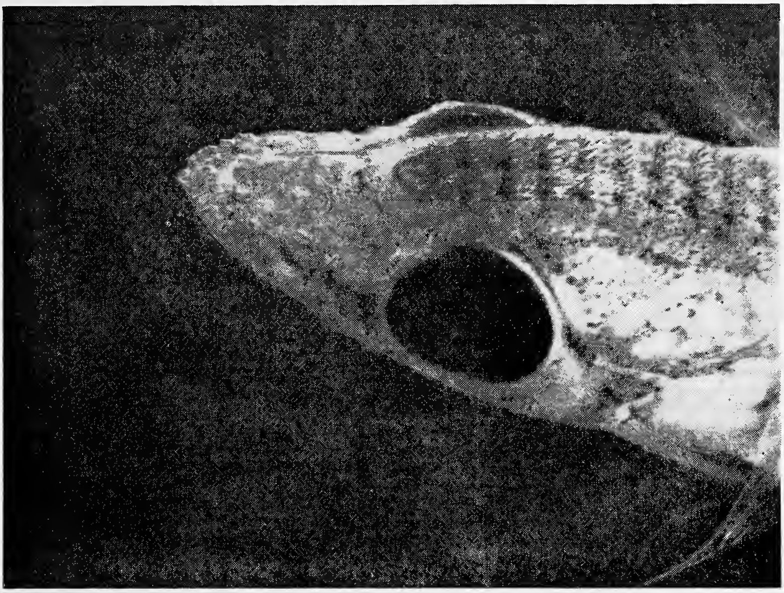

Fig. 33. *Remore remora*, 15 mm. Photograph of head from above showing larval suckers.

Another missing-link-of-a-character has recently come to my attention.

The material to which the following account refers consists of two specimens of *Remora remora;* both taken on the Third Bermuda Oceanographic Expedition of the Department of Tropical Research of the New York Zoological Society.

A. 88 mm. standard length, No. 9358, KOH No. 854, taken from *Carcharias obscurus*, at surface, May 26, 1931, near Nonsuch, Bermuda.

B. 15 mm. standard length, No. 23,459, KOH No. 1013, Net 1304, 8 miles southeast of Nonsuch, 400 fathoms, September 15, 1931.

Specimen B in life was purplish brown, the anterior portions of lips, tips of pectorals and outer tips of caudal lobes pale grayish. Both fish have been thoroughly dyed and cleared.

Examining the 88 mm. *Remora*, I wondered, as often before, at the extent of the protruding under lip in these young specimens.

The dye had made the remarkable teeth stand out with great distinctness. They somewhat resembled the teeth of a horse, rows upon rows of them, raised on the end of slender stalks and aligned in long palisades. In the lower jaw were still more dental multitudes, showing sharp, incurved hooks at the summits.

Cephalic Sucking Disk

The remarkably effective sucking disk on the head was fully developed and functional in this fish. Each half of the eighteen transverse lamellae consisted of a broad proximal sheet of tissue, giving rise, along the posterior edge, to more than 70 finger-like tentacles arranged in three rows; the anterior row of shortest ones numbered 40, a middle row of medium length tentacles had 17, and the posterior row of long ones had the same number.

I next examined a much smaller specimen less than an inch in standard length, 15 mm., and was at once impressed with the simplicity and undeveloped condition of the sucking disk. It was perfect in general shape, showing no transition from the original dorsal fin from which it was derived. The rays of the fin must at some still earlier stage have split, spread out sideways and become changed into movable, transverse plates which have the power of being raised and lowered and creating a vacuum. These plates in my infant shark-sucker were very imperfect. Instead of each lamella being armed with three rows of various sized tentacles and a complicated system of water-tight compartments, each half of a transverse section possessed only 6 or 7 long, flattened, thick tentacles with no developed flaps or membranes. In fact there was sufficient basal tissue only to hold the tentacles together. Their relative length in the two fish was 14 to 2; their relative average number 74 to 6.

It was evident that this elaborate and specialized structure was still in process of development, at present quite useless as the factor in progress and movement which it had been ancestrally when a proper dorsal fin. On the other hand, it was equally unable as yet to perform its ultimate, opposite function of an anchorage, an inhibitor of movement.

Such a condition in any organ implies one of two things, either that the creature can get along for a time without the ultimate change of function of the structure, or that it has some temporary

substitute which for the time being suffices as a stop gap. A glance at the jaws of the small *Remora* showed that the latter condition had been fulfilled.

We know nothing of the habits of the newly-hatched or post-larval shark-sucker, but it seems reasonable that as it is to spend its life creeping over the body of a shark or other large creature of the sea, that the sooner it develops some method of attachment, the better.

Labial Suckers

The teeth of our half-inch fish were few in number, minute and inconspicuous, but the fleshy portion of the lower jaw was

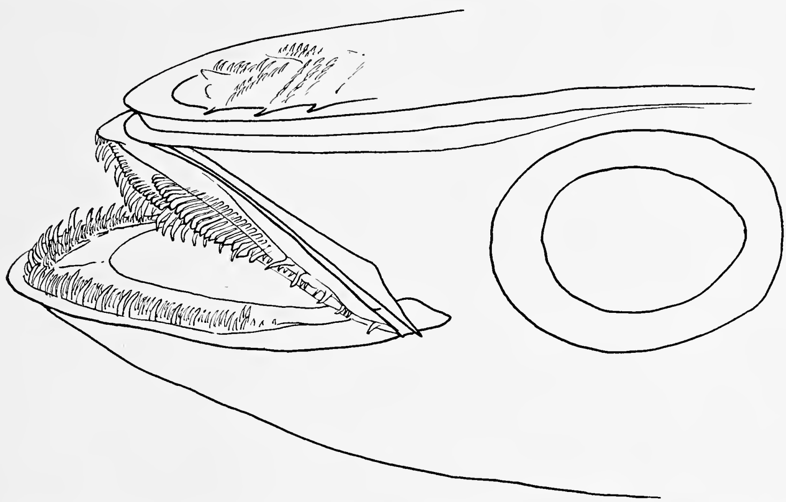

Fig. 34. *Remora remora*, 88 mm. Lateral view of head, showing complicated lines of teeth.

undershot even more than in the adult; precisely as 68 to 57, or a full fifth. This projecting lip and the anterior portions of the upper jaw were provided with a formidable armature of suckers, 26 in all. In general appearance they were like the corresponding organs on the arms of an octopus, a short, thick pedicle expanding distally into a rounded, inverted cup with a circular upper rim. The largest was .11 mm. in diameter. There were 6 along the anterior edge of the upper jaw, and 3 on each side of the symphysis, directed obliquely up and forward. On the lower jaw were 20 suckers, ar-

ranged in two rows, 12 along the edge of the jaw and 8 in a second line. Considering the suckers in one-half of the lower jaw, I found that in the first row the central four were small and placed close together, the outer two considerably larger, about twice, and well separated from each other. The second row showed a gradation in size from the symphysis outward, the outermost, however, being smaller than the corresponding one of the first row. The lower jaw suckers were directed upward and very slightly backward.

Teeth

The teeth were difficult to find, but once located were distinct. Near the front of both upper and lower jaws, but with a wide symphysial gap, was an upper row of 8 or 9 and a lower row of 8.

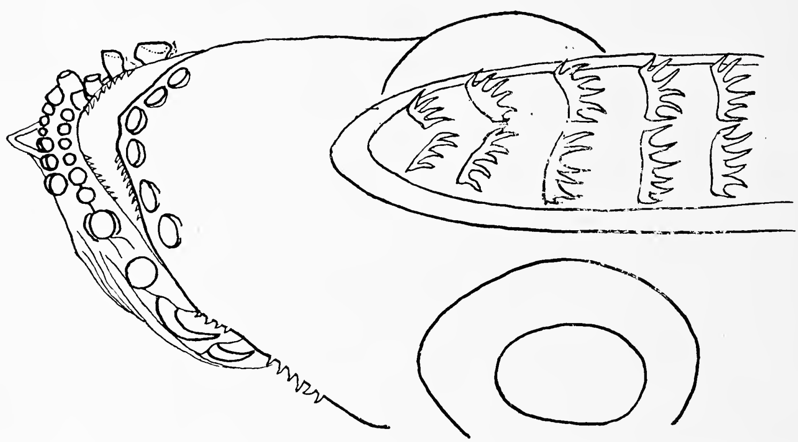

Fig. 35. *Remora remora*, 15 mm. Oblique view of head showing larval suckers, and undeveloped teeth and sucking disk.

Along the lateral edge of the premaxillary, where it overhung the mandible, and beyond the outermost sucker, was an irregular row of short, out-jutting teeth—10 to 15 in all.

Most remarkable, however, were two pairs of large, sharply curved fangs, beyond the outermost sucker on the lower jaw, and curved laterally and very slightly upward. The flatness of the curvature, together with their extra-buccolabial position rendered them useless for the capture or retention of prey, and unless they are of help in hooking over the upper jaw, thereby locking the two

together when these are in use as an attaching organ, I cannot divine their function.

Dr. Tåning[2] has studied post-larval stages of *Remora* and *Echeneis* from the point of view of the gradual shifting forward of the cephalic disk. Although he had specimens of *Remora remora* of 5, 6, 10, 12, 18 and 25 mm., he makes no mention of labial suckers, but in his illustration shows sparse but well-developed teeth along the lower jaw from the 9.8 mm. individual up to that of 25 mm. length. The situation of the disk in my 15 mm. specimen is more advanced than in Tåning's 18 mm. fish, as he writes of this individual, "*le bord antérieur du disque est placé au bord antérieur des yeux,*" while in mine the disk extends one-third of the eye's diameter in advance of the eye's anterior rim.

Scales

Scales are wholly absent from the 15 mm. specimen and in preserved remoras of large size the skin usually shows only irregular, deep reticulations of mucus, the scales being hidden in the sunken interspaces. In my cleared individual of 88 mm. the scales are conspicuous and cover the entire surface. They are small and exceedingly numerous and very characteristic in shape. There are about 40 scales to every square millimeter and a most conservative estimate of the body area gives a minimum total of at least 100,000 scales on head, fins and body.

Superficially they remind one of nothing so much as a multitude of the bowls of table- and tea-spoons stuck obliquely into the skin, with the concavities facing forward. If they were not imbedded in mucus during life they would form most efficient brakes on any rapid forward progress through the water. At first they seem to be quite irregularly inserted, and indeed there is no hint of regular rows for more than a few scales at a time, but in about three cases out of five and even more along the sides, each large scale has two small scales sprouting from its anterior base.

In the space of a square millimeter there are 12 to 15 large scales with attendant and other scattered small scales. Sometimes there is only one small scale to a large one, or three smalls may be in a longitudinal row to fill an interspace between two large ones.

[2] *Comptes rendus des séances de l'Académie des Sciences*, Vol. 182, p. 1293.

Fig. 36. Scales of 88 mm., *Remora remora*, horizontal view.

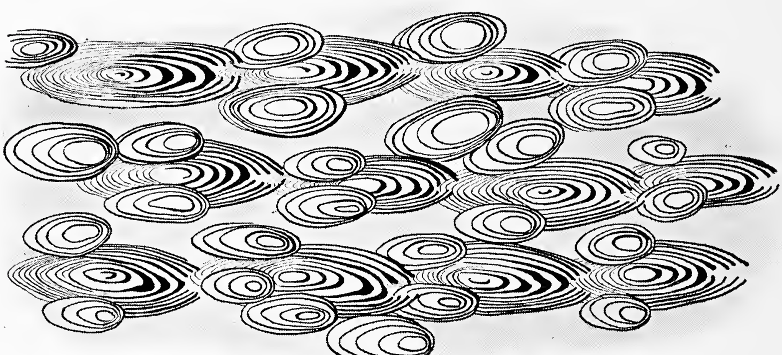

Fig. 37. Scales of 88 mm., *Remora remora*, vertical view.

The scales are regular ovals, the larger ones .33 and the smaller .11 mm. in length. In the cleared tissues their entire outline can be distinctly seen, all the circuli having taken up considerable stain. The rings vary from 6 to 12, usually 8, and they may be very thin and close together or thick. Starting from a small central oval they are all complete in the small scales and a few of the large ones, but in the majority of the latter they are broken or worn away at the tip so that the outermost three or four do not meet. This would suggest some use in regard to progress over the body of the shark, or of assistance in clinging. On the other hand, the terminal breaks may act as channels for facilitating the distribution of mucus. At present our safest comment is "I don't know."

The scales are identical in size, shape and structure everywhere on the fish. The only variation in arrangement is a diminishing number of small scales along the mid-back and mid-ventral areas, fewer of the regular trinities being found in these places than elsewhere. Scales occur on all available parts of the head, extend some distance up the pectorals and vertical fins, and almost to the tips on the ventrals and especially on the caudal.

The lateral line is very well marked in the dyed tissues, in the 88 mm. *Remora* the components taking up stain almost as thoroughly as bone. The line is composed of a series of deep-set, short, slenderly barrel-shaped segments, pointing obliquely out and backward, the upper end showing many fine perforations. Posteriorly these separate units elongate and form an almost continuous tube.

The line begins just beneath the shelter of the overhanging lateral edge of the sucking disk, at the vertical of the 13th lamella from the front, close above the insertion of the pectoral. It rises in a gentle curve, keeping parallel with the curving posterior end of the disk, and then, as gently, and in a long, even curve, slopes down to a level with the mid-side. This descending curve is so gradual that it does not straighten out until at the vertical of the origins of the soft dorsal and the anal fins. From here it extends straight backward, exactly bisecting the peduncle, and out to the very tail tip, ending in a long, colorless tube with slight openings here and there, its open end only 1.5 mm. from the tips of the central caudal rays.

In the 15 mm. shark-sucker the lateral line is also conspicuous but of course not nearly so deeply stained as in the more adult

specimen. It shows as a continuous line beneath the surface. The contour is different from that in the adult, there being no anterior rise, but the line dropping down in a long, rather straight descent from its origin above the pectoral, to the mid-line of the body. It is traceable only to the base of the caudal and not distinguishable along the rays.

Fins

The relative ontological changes in length of the disk and of the base of the soft dorsal and anal fins are best shown by the direct comparison of their percentages. In the 15 mm. *Remora* the length of the soft dorsal is 72 per cent. of the disk length, whereas in the larger, 88 mm. fish, the former has equalled and surpassed the disk by a third, measuring 133 per cent. The same is true of the anal fin length, this being 78 per cent. of the disk length in the young, and 142 per cent. in the older fish.

In both there are 18 transverse lamellae in the first dorsal or cephalic sucking disk. The soft dorsal count is 25½ in the small remora and 24½ in the larger. The first few rays increase rapidly in length, reaching greatest height at the 6th in the smaller and at the 8th in the larger, then shortening and rising gradually to the last, which is relatively twice as long in the 15 mm. fish as in the other. All the anterior dorsal and anal rays show a slight branching at the tip and a distinct segmentation, differing thus in no particular from the succeeding rays.

The anal count is 22 in the young and 23½ in the older fish. The pectorals are broad and rounded, with I, 20 in the young fish and I, 26 in the larger The spines are very strong and as prominent as are those of the ventrals, whose count is, of course, I, 5.

As regards the position of the pectoral fins, the small *Remora* shows a depth of body at the pectorals of only 37 per cent. of the larger. The position percentages of these fins can be compared directly with one another:

15's depth at pectoral compared with 88's—37 per cent.
15's distance from dorsal surface to pectoral, to 88's—50 per cent.
15's distance from pectoral to ventral surface, to 88's—50 per cent.
15's vertical base length of pectoral compared with 88's—25 per cent.

So the relative dorso-ventral position is changed hardly at all in the two, the shift in measurements being due to the great relative

increase in the vertical extent of the base of the fin itself, from less than a third to almost one-half of the entire body depth.

The ontological changes in length of the paired fins offer great contrasts; in the half-inch *Remora,* in comparison with the head length, the pectoral length is 38 per cent., and that of the ventrals 24 per cent. In the 88 mm. fish both are exactly the same length, the ventrals having caught up with the pectorals, an increase of over half, or 54 per cent. of the length of the head.

The ventrals are quite free in the post-larva, indicating better natatory ability than in the older individual. In the latter the spine measures 12.8 mm., and the inner or 5th ray is 8.5 mm. long, and for exactly two-thirds of this length the ray is bound tightly, goby-like, to the skin beneath.

The outer, functional caudal rays in the small *Remora* are longer than the central ones, but that is all that can be said of the shape. The 88 mm. fish has a slightly emarginate or shallowly forked tail, the inward slope being almost straight. The count is:

15 mm. – (9)9 + 8(8)
88 mm. – (13)9 + 8(12)

The most striking thing about the tail in the larger fish is the fact that all the functional caudal rays, except the central two, are split vertically and sprung widely apart at the tips for a distance of 5 mm. This is independent of the usual distal branching of these rays. It is very slightly noticeable in the small specimen. The tips of the two central rays which bound the end of the lateral line, are normal and the tips strong and unsplit. In the case of several hundred species of deep sea and shore fish which have been cleared and stained by an identical process, this splitting has occurred only in this species. While it may very possibly have no important significance whatever, yet is it worthy of note that the cephalic disk was probably originally formed by the lateral splitting of the rays of the first dorsal fin.

General Proportion of Growth

In the case of six measurements I am able to compare fish of four ages:

A—is my 15 mm. Remora.

B—is a Remora taken at sea 35 miles southeast of Beaufort, North Carolina (Gudger, 1926).
C—is a fish which I collected at Key West (Gudger, 1926).
D—is my 88 mm. Remora.

The measurements are the times contained in the standard length and show an almost uniform progression:

	A	B	C	D
Total length	17.6 mm.	30 mm.	49 mm.	105 mm.
Standard length	15 mm.	27 mm.	43 mm.	88 mm.
Disk length	3.88	3	2.96	2.8
Disk width	16.5	6.75	7.17	5.6
Head width (at base of P)	8	6.75	5.7	5.2
Head length	4.3	3.6	3.5	3.3
Length base of soft dorsal	2.7	2.8	3.4	3.7
Length base of anal	3	3.18	3.58	4

Relative measurements between my two fish are as follows:

Standard length	15 mm.	88 mm.	17 per cent. of 15 to 88 mm. fish.
Depth (in length)	1.6 (9.3)	11.5 (7.6)	14 per cent. of 15 to 88 mm. fish.
Head (in length)	3.48 (4.3)	23.5 (3.3)	14.8 per cent. of 15 to 88 mm. fish.
Eye (in head)	.91 (3.8)	4.5 (5.2)	20 per cent. of 15 to 88 mm. fish.
Snout (in head)	1.18 (2.9)	11.5 (2)	10.2 per cent. of 15 to 88 mm. fish.
Maxillary (in head)	1.67 (2)	11 (2.14)	15.2 per cent. of 15 to 88 mm. fish.

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NOMENCLATURAL NOTES ON THE SHORE FISHES OF BERMUDA[1]

BY WILLIAM BEEBE

AND

JOHN TEE-VAN

(Fig. 38)

SYSTEMATIC TABLE OF CONTENTS

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[1] Contribution, New York Zoological Society, Department of Tropical Research, No 409.

Introduction

While preparing a Field Book of the Shore Fishes of Bermuda[2] it became evident that a number of changes would have to be made in the list of species as recorded in the literature of Bermuda. As it is undesirable to include the discussions involving these species in the Field Book, the following pages summarize the changes suggested and made by us. These alterations, such as the elimination of species based upon questionable records, synonymizing of species by reason of new knowledge of their life histories and color phases, corrections of misidentifications, etc., are the result of four seasons' work in the field at Bermuda. This has been carried on in the course of the Oceanographic Expeditions of the Department of Tropical Research of the New York Zoological Society, at Nonsuch and at the Biological Station for Research. This field work has been coupled with the examination and comparison of Bermuda and West Indian materials, types and otherwise, in our own collections, in the Field Museum at Chicago, the Museum of Comparative Zoology at Cambridge, the United States National Museum at Washington and the American Museum at New York.

No attempt has been made at complete synonomy, but only pertinent Bermuda references are included.

Family CLUPEIDAE

Sardinella anchovia Cuvier and Valenciennes

Sardinella anchovia Cuvier and Valenciennes.

Sardinella anchovia Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XX, 1847, *p.* 269. Bean, *Field Col. Mus., Zool. Ser.*, VII, *No.* 2, *p.* 34.

Sardinella pinnula Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 122.

The types of *pinnula* in the U. S. Nat. Mus., the Bermuda specimens that Bean recorded as *anchovia*, a number of Bermuda specimens taken by us, and a specimen of *anchovia* fron Long Island have been examined by us. We can find no reason for not calling them all *anchovia*.

In the revision of *Sardinella* by Regan (1917), *pinnula*, described in 1912, was overlooked, but a specimen of *aurita*, under which *anchovia* was synonymized, was recorded from Bermuda. All of the Bermuda specimens agree with each other and disagree with Regan's definition in lacking a black opercular spot, which seems to be the only character separating *pinnula* from *anchovia*. However, in this connection it is of interest to note that in the Long Island

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[2] Field Book of the Shore Fishes of Bermuda, by William Beebe and John Tee-Van, published under the auspices of the New York Zoological Society by G. P. Putnams Sons, 1933.

specimen and in some of our Bermuda fish, there is an appearance of a dusky spot caused by the dark gill cavity being viewed through a small transparent portion of the opercle. In the figure given by Cuvier and Valenciennes of *aurita* there is no dark opercular spot, although the dark projecting gill-filaments might be mistaken for one. The latter authors expressly state that there is a black opercular spot in *anchovia* and *aurita*.

Harengula macrophthalmus (Ranzani)

Harengula macrophthalmus (Ranzani).

Clupea macrophthalmus Ranzani, *Nov. Comm. Acad. Sci. Bonon.*, V, 1842, *p.* 320.

Sardinella macrophthalmus Bean, *Field Col. Mus.*, *Zool. Ser.*, VII, *No.* 2, 1906, *p.* 34.

Harengula maculosa (not of Cuvier and Valenciennes) Regan, *Ann. Mag. Nat. Hist.*, (8) XIX, 377–395.

We prefer the treatment accorded to the genus *Harengula* by American authors, as opposed to Regan's revision of the group. Accordingly we retain *sardina* as a valid species, and the Bermuda specimen assigned to *maculosa* by Regan is placed under *macrophthalmus*.

Family DUSSUMIERIIDAE

Jenkinsia lamprotaenia (Gosse)

Jenkinsia lamprotaenia (Gosse).

Clupea lamprotaenia Gosse, *Nat. Sojourn in Jamaica*, 1851, *p.* 291, *pl.* 1, *fig.* 2.

Dussumieria stolifera Jordan and Gilbert, *Proc. U. S. Nat. Mus.*, VII, 1884, *p.* 25.

Stolephorus viridis Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 122.

Jenkinsia lamprotaenia, Beebe and Tee-Van, *Zoologica*, Vol. X, *No.* 1, 1928, *p.* 43.

The types of *Stolephorus viridis* Bean were examined, and as already stated by Nichols, they are *Jenkinsia lamprotaenia*.

Jenkinsia stolifera has also been placed under the synonomy of this species by the present authors (l. c.).

Family ENGRAULIDAE

Anchoviella choerostoma (Goode)

Anchoviella choerostoma (Goode).

Engraulis choerostoma Goode, *Amer. Journ. Sci. Arts*, Aug. 1874, *p.* 125.

Anchoviella choerostoma var. *atlantica* Borodin, *Bull. Vand. Oceano. Mus.*, I, *Art.* 1, 1928, *p.* 7.

The characters upon which the variety *atlantica* were established are certainly not valid. In the account of *choerostoma* given by Jordan and Seale

in their "Review of the Engraulidae" (Bull. Mus. Comp. Zool. Cambridge, LXVIII, No. 11, p. 404) the range of variation easily includes the characters of *atlantica*. In addition Borodin assumed that *choerostoma* was from the Pacific and that it had not been reported from Atlantic Panama. The species was originally described from Bermuda and has since been reported from various West Indian islands as well as from the Atlantic coast of Panama.

Family OPHICHTHYIDAE

Ophichthus havannensis (Bloch and Schneider)

Ophichthus havannensis (Bloch and Schneider).

Muraena havannensis Bloch and Schneider, *Syst. Ichth.*, 1801, *p.* 491.

Ophichthus triserialis (not of Kaup) Goode, *Am. Journ. Sci. Arts.*, XIV, Oct., 1877, *p.* 293; Bean, *Field Col. Mus., Zool. Ser.*, VII, *No.* 2, 1906, *p.* 31.

The Bermuda specimen upon which Goode's record was based, has been examined by us. We see no reason for referring it to the Pacific coast form as opposed to the Atlantic geminate species, and the specimen agrees well with the descriptions of *Ophichthus havannensis* as viewed in the light of recent knowledge of the species. The older descriptions specify uniserial teeth in the lower jaw for *havannensis* and biserial for *triserialis*. West Indian material, however, represented by Metzelaar's (1919) Curacao specimen, shows a slight overlapping of teeth anteriorly, so that for a short space there is a double row of teeth in the lower jaw. This condition is also found in Goode's Bermuda specimen. Goode evidently adhered strictly to the then existing definitions, resulting in the assignment of the Bermuda fish to a Pacific form.

Sphagebranchus ophioneus Evermann and Marsh

Sphagebranchus ophioneus Evermann and Marsh 1900.

Sphagebranchus ophioneus Evermann and Marsh, *Bull. U. S. Fish Comm.*, XX, 1900, *p.* 73, *fig.* 7.

Sphagebranchus anguiformis (not of Peters), Barbour, *Bull. Mus. Comp. Zool.*, XLVI, *No.* 7, 1905, *p.* 112.

The young specimen (107 mm.) listed under *anguiformis* by Barbour has been examined. From its proportions (Head 11.2 in length, 3.2 in trunk; head and trunk 2.75 in length) and other characters, it is closer to *S. ophioneus* than to *anguiformis*, and as we have taken a much larger specimen of the former, it is undoubtedly that species. There is a note by Seale in the bottle containing the Barbour specimen, listing his disagreements with the identification.

Family MURAENIDAE

Enchelycore brunneus (Nichols)

Enchelycore brunneus (Nichols).

Gymnothorax brunneus Nichols, *Proc. Biol. Soc. Wash.*, XXXIII, 1920, *p.* 59.

Examination of the type of this species shows that it belongs to the genus *Enchelycore,* as it possesses the slit-like posterior nostril of that genus. It is probable that this species will later be shown to be the same as *Enchelycore nigrocastaneus* Cope, but we have had no material with which to compare the two forms.

The name *Gymnothorax brunneus* was also employed by Herre in 1923 for a Philippine eel (Philippine Journ. Sci., Manilla, P. I., 23, 1923, p. 212, fig. 13). We take pleasure in renaming the latter form **Gymnothorax herrei.**

Gymnothorax ocellatus Agassiz

Gymnothorax ocellatus Agassiz.

Gymnothorax ocellatus Agassiz, in Spix, *Pisc. Brasil.*, 1828, p. 91, *pl.* 50*b*.

?*Lycodontis jordani,* Evermann and Marsh, *Bull. U. S. Fish. Comm.*, XX, 1900, (1902), *pt.* 1, *p.* 78, *pl.* 2; Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, *p.* 32.

We have not examined specimens of either of the forms mentioned above. But in reviewing the original descriptions of the two species, it became evident that they are very close if not identical. When *jordani* was originally described, the serrations on the teeth were not noticed. Meek and Hildebrand in "The Marine Fishes of Panama," part I, p. 167, state of the single Panama specimen of *jordani* taken by them, "We have compared it with the type of the species with which it appears to agree quite well. The teeth were, however, erroneously described as being smooth, whereas they are distinctly serrate at least on posterior margin near the base. Its relationship therefore is with *G. ocellatus.*"

G. ocellatus is a form with widely varying color variations, as can be witnessed by the number of names that have been erected for various specimens, and it is very probable that *jordani* is merely a xanthistic phase.

The four eels listed below are removed from the Bermuda faunal list. We have been unable to find the specimens to which they refer, and in all of the cases there are closely related species that have been found in Bermuda since the publication of the original record.

Leptocephalus sp.

Leptocephalus sp.

Leptocephalus sp., Goode, *Am. Journ. Art. Sci.*, XIV, 1877, *p.* 293.

This record is ignored as we have been unable to find the specimens and consequently to ascertain whether it represents a larval eel or a conger. The former are abundant off Bermuda, and a new species of Conger, *Conger harringtonensis,* has recently been described from Bermuda by Mowbray.

Ahlia sp. nov.

Ahlia sp. nov.

Ahlia sp. nov., Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 121.

We have been unable to find the specimen upon which this record is based. The record may possibly refer to either one of two West Indian species of *Myrophis* recently described by Parr and by Breder. These have been taken by us in Bermuda. The genera *Myrophis* and *Ahlia* have been synonymized by Parr.

Gymnothorax (resembling **verrilli**)

Gymnothorax (resembling *verrilli*).

Lycodontis (resembling *verrilli*) Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 121.

We have not been able to find the specimen referred to in this reference. The closely related *G. vicinus*, first recorded by Goode from Bermuda in 1877, but ignored by Bean in his check-list (1906) has been found by us in Bermuda, and this may be the form mentioned here by Bean.

Muraena sp. nov.

Muraena sp. nov.

Muraena sp. nov., Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 121.

We have not found the specimen upon which Bean established this record. It may possibly refer to the new species described in 1930 by Mowbray, *Muraena aureus.*

Family SYNODONTIDAE

Synodus foetens (Linnaeus)

Synodus foetens (Linnaeus).

Salmo foetens Linnaeus, *Syst. Nat., Ed.* XII, 1766, *p.* 513.

Synodus lacerta (not of Risso) Goode, *Bull. U. S. Nat. Mus.*, V, 1876, *p.* 68.

Synodus saurus (not of Linnaeus) Barbour, *Bull. Mus. Comp. Zool.*, XLVI, No. 7, 1905, *p.* 113; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 35.

We have not been able to find the specimens upon which the Bermuda records of the European Lizardfish are based. Some of the recent studies of larger specimens of *foetens* taken along the coast of the United States show dimensions and proportions overlapping those of *saurus.*

Considering the lack of material and the peculiarities of distribution coincident with the admittance of a European shallow-water bottom-fish to the Bermuda fauna, it seems best to think that the specimens were identified as *lacerta* and *saurus* at a time when the variation in *foetens* was not sufficiently well-known.

Family HOLOCENTRIDAE

Holocentrus tortugae Jordan and Thompson

Holocentrus tortugae Jordan and Thompson.

Holocentrus tortugae Jordan and Thompson, *Bull. U. S. Bur. Fisheries*, XXIV, 1904 (1905), *p.* 236, *fig.* 1.

Holocentrus puncticulatus Barbour, *Bull. Mus. Comp. Zool., Cambridge*, XLVI, 1905, *p.* 117.

Holocentrus siccifer (not of Cope) Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 43.

According to the revision of the genus *Holocentrus* given by Parr (1930, p. 34) the specimen assigned to *siccifer* by Bean, must be placed under *tortugae*,—thus removing this problematical species from the Bermudian faunal lists. The dimensions given by Bean for his Bermuda specimen readily fall within the limits of *tortugae* as stated by Parr.

Holocentrus vexillarius (Poey)

Holocentrus vexillarius (Poey).

Holocentrum vexillarium Poey, *Memorias*, II, 1862, *p.* 158.

Holocentrus brachypterus Poey, *Repertorio*, I, 1866, *p.* 184; Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 121.

Field notes made in Bermuda confirm Parr's comments on the relationships of these forms.

Family SYNGNATHIDAE

Corythoichthys ensenadae Silvester

Corythoichthys ensenadae Silvester.

Corythoichthys ensenadae Silvester, *Carn. Inst. Yearbook*, 14, 1915, *p.* 215; Mowbray, *Copeia*, 104, 1922, *p.* 19.

It is probable that this species belongs to the genus *Micrognathus* as understood by Duncker. However, the type of the species has disappeared from the collections of Princeton University and we have been unable to trace it, so that the proof of this conjecture must await examination of further material.

Hippocampus punctulatus Guichenot

Hippocampus punctulatus Guichenot.

Hippocampus punctulatus Guichenot, in Ramon de la Sagra, *Hist. Ile. Cuba, Poiss.*, 1853, 174, *pl.* 5, *fig.* 2; Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, *p.* 40.

Hippocampus antiquorum (not of Leach) Goode, *Am. Journ. Sci. Arts*, XIV, Oct. 1877, *p.* 291.

Hippocampus hippocampus (not of Linnaeus) Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, *p.* 40.

Hippocampus brunneus Bean, *Proc. Biol. Soc. Wash.*, XIX, 1906, *p.* 32; Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, *p.* 39, *fig.* 1.

Hippocampus hudsonius (not of DeKay) Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, *p.* 40.

Hippocampus stylifer (not of Jordan and Gilbert) Bean, *Field Col. Mus.*, Vol. VII, 1906, No. 2, *p.* 40.

? *Hippocampus kinkaidi* Townsend and Barbour, *Bull. N. Y. Zool. Soc.*, No. 23, 1906, *p.* 304, *fig.*

We have a considerable number of Bermuda seahorses in our collections and we have also examined all the specimens taken and reported upon by Bean with the exception of the type of *brunneus*. We are of the opinion that all of these Bermuda fish, as explained below,—Bean's *hudsonius*, *punctulatus*, *brunneus* and *stylifer*, are the same, and that the name *punctulatus* Guichenot seems to be the best one to apply to the Bermuda seahorse. *Hippocampus kinkaidi*, described by Townsend and Barbour from Bermuda, is a questionable form. Its status is uncertain and for that reason we place it beneath *punctulatus* with a question. Under any circumstances, the need for a revision of the West Indian seahorses is apparent.

The Bermuda seahorses examined by us divide into two markedly different groups, the first with few spines and very few dermal filaments, the second group markedly spinose and with many filaments. The first group are all males and the second group females. There is considerable variation in depth of body but we have been unable to correlate this with any other factors. As far as coloration, which is admittedly a character of little if any value in this group, is concerned, the preserved specimens give no hint of species differentiation. The color of the living fish in the field is practically any color that happens to surround the fish.

The dorsal fin count in the Bermuda fish varies from 17 to 20, the fin being situated on 2 or 2½ body plus 1 or ½ caudal segments.

Modern authors, such as Jordan and Evermann, Bean 1906, etc., have distinguished *punctulatus* from *hudsonius* mainly on the possession of 17 to 18 rays in the dorsal fin of the former and of 19 in the latter. This has been done despite the fact that Guichenot in the original description of *punctulatus* listed 22 dorsal rays and showed 21 in his figure.

In reviewing the various specimens the following notes were made:—

The large specimen called *hudsonius* by Bean (Field Mus. No. 5064) does not differ from the specimen called *punctulatus* by him, except for the extra dorsal ray. The small fish identified by Bean as *hudsonius* is a female and does not differ from similar specimens identified as *punctulatus*.

The specimen called *stylifer* by Bean possesses 18 dorsal rays and is similar to the others in other ways. The dorsal fin is damaged, but there is no difficulty in tracing the rays with a binocular microscope. As *stylifer* has been reported as a species with 16 rays only in the dorsal fin, and as we believe the fin, because of its damaged condition, to have been wrongly counted, we see no reason for retaining this form as a valid Bermuda species.

Hippocampus brunneus Bean 1906, originally described from Bermuda, has already been included as a nominal color form of *punctulatus* by Fowler (1915, p. 446), and we agree with this decision.

Hippocampus kinkaidi is similar to some of our smaller fish, although its armature is slightly different. We have not examined the type specimen. Considering the variation within the Bermuda seahorses, we are temporarily including it under *punctulatus*.

The following table, showing Bean's specimens and a selection of specimens from the Bermuda Oceanographic Expedition, plus the description of *kinkaidi* will tend to show the similarities of the various fish:

Specimen Number	Sex.	Length, from post. margin of coronet to tip of tail. mm.	Length of Head,* mm.	Snout in head.	Eye in Head.	Post-orbital Head in Head.	Depth in Head.	Body Segments.	Caudal Segments.	Dorsal		
										Fin Rays.	on Body Segments.	on Tail Segments.
brunneus, type, Field Mus. 5494	♂			2.5	6	2.5	1.33	11	35	18	3,—2½ in fig.	1
Bermuda Ocean. Exped. No. 9321.	♂	63	12.7	2.6	5.2	2.3	1.4	12	35	20	2½	1
Bermuda Ocean. Exped. No. 9143.	♂	86	19.2	2.7	5.6	2.3	1.2	12	33	18	2½	½
Field Museum. No. 5064.	♂	88	19.8	2.7	5.6	2.3	1.15	12	34	19	2	1
Field Museum. No. 5495.	♂	126	25	2.5	5.5	2.2	1.1	12	35	18	2	1
kinkaidi, type description.	♀	1.5 in. long	?	2.5	6	2.5	2 ?	12	?	19	3,—2½ in fig.	1
Bermuda Ocean. Exped. No. 8897	♀	41	11	2.7	5	2.7	1.9	12	35	18	2	1
Bermuda Ocean. Exped. No. 9271.	♀	59	13	2.6	5.2	2.5	1.7	12	34	?	2	1
Field Museum. No. 5066	♀	62	14.3	2.4	5.8	2.4	1.6	12	33	18	2½	1
Field Museum. No. 5065.	♀	64	14.7	2.45	5.5	2.45	1.6	12	35	19	2	1
Bermuda Ocean. Exped. No. 8878.	♀	69	16.5	2.54	5.9	2.1	1.4	12	35	18	3	1
Bermuda Ocean. Exped. No. 8908.	♀	89	20.5	2.2	5.8	2.4	1.2	12	35	19	2	1
Bermuda Ocean. Exped. No. 9094.	♀	98	24	2.3	6	2.3	1.5	12	35	18	2	1

* Measured from snout to gill-opening.

Family FISTULARIIDAE

Fistularia tabacaria Linnaeus

Fistularia tabacaria Linnaeus.

Fistularia tabacaria Linnaeus, *Syst. Nat.*, *ed.* X, 1758, *p.* 312.

Fistularia petimba Günther, *Challenger Exped. Rep.*, *Shore Fishes*, *p.* 68; Meek and Hildebrand, *Field Mus. Nat. Hist.*, *Zool. Ser.*, XV, *Part* 1, 1923, *p.* 252.

We consider *petimba* as here stated to be the same as *tabacaria*, following Fowler (Proc. Acad. Nat. Sci. Phila., 1921, p. 439). Bean, although the Bermuda record existed before his 1906 check-list was published, evidently thought the same, as he did not include the species in his report.

Family ATHERINIDAE

Atherina harringtonensis Goode

Atherina harringtonensis Goode.

Atherina harringtonensis Goode, *Am. Journ. Sci. Arts., 3rd ser.*, XIV, No. 82, 1877, *p.* 297.

Menidia menidia (not of Linnaeus) Barbour, *Bull. Mus. Comp. Zool., Cambridge*, XLVI, 1905, No. 7, *p.* 116.

We have examined specimens taken in Bermuda by Barbour and labelled *Menidia menidia,* and presumably the specimens upon which the above record is based. These fish are *Atherina harringtonensis,* and this identification is borne out by Barbour's note that they were exceedingly common, which is certainly true of *harringtonensis* in Bermuda. In addition to this fact Barbour did not record *Atherina harringtonensis.* We have seen no specimens of *Menidia* in our four years in Bermuda.

Family MUGILIDAE

Mugil curema Cuvier and Valenciennes

Mugil curema Cuvier and Valenciennes.

Mugil curema Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XI, 1836, *p.* 64 (87).

Mugil trichodon (not of Poey) Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, 1906, *p.* 41.

We have examined four of the series of specimens called *M. trichodon* by Bean (Field Mus. Nos. 5210 (2), 5213 and 5215). These fish possess eight anal rays, but in all other characters agree with *Mugil curema.* This combination of characters is present in many of our own fish. However, the Bean specimens labelled *trichodon,* have 36 to 38 scales from the shoulder to the hypural, plus one or two on the base of the caudal fin, while *trichodon,* according to specimens and descriptions, is a large scaled species with from 29 to 31 scales in the lateral line.

These records of *trichodon* therefore, ought to be changed to *Mugil curema,* and the current descriptions of the latter species altered to allow variation of one ray in the anal fin, the descriptions thus reading Anal III, 8 or 9. This variation has been recognized previously by Jacot (1920).

Examination of specimens in collections has shown that too much dependence has been placed in species determination of mullets, upon the anal fin ray count,—almost any mullet in the West Indian fauna possessing 8 anal rays has been placed in *trichodon.*

True *Mugil trichodon* exists in Bermuda as we have specimens in our collections.

Family STROMATEIDAE?

Eucrotus ventralis Bean

Eucrotus ventralis Bean.

Eucrotus ventralis Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 123.

The type of this pelagic species, recorded as being in the Bermuda Museum of Natural History, is now in the collection of the American Museum of Natural History, New York City.

Family CARANGIDAE

Decapterus punctatus (Agassiz)

Decapterus punctatus (Agassiz).

Caranx punctatus Agassiz, in Spix, *Pisc. Brasil,* 1829, *p.* 108, *pl.* 56*a.*

Decapterus punctatus Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2. *p.* 48.

Decapterus scombrinus (not of Valenciennes) Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 48.

We consider the two specimens referred to by Bean as *D. scombrinus* to be variants of *punctatus.* Bean, in his own account, also questioned these fish, as he says,—"These two examples are referred to *D. scombrinus,* although it is doubtful if this species be distinct from *punctatus.*"

Decapterus macarellus (Cuvier and Valenciennes)

Decapterus macarellus (Cuvier and Valenciennes).

Caranx macarellus Cuvier and Valenciennes, *Hist. Nat. Poiss.*, IX, 1833, *p.* 33 (40).

Decapterus macarellus, Parr, *Bull. Bingham Oceano. Coll.,* Vol. III, *Art.* 4, 1930, *p.* 46.

Decapterus sanctae-helenae (not of Cuvier and Valenciennes) Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 121.

We follow Parr in referring the western Atlantic specimens of *sanctae-helenae* to *macarellus.*

Caranx crysos (Mitchill)

Caranx crysos (Mitchill).

Scomber crysos Mitchill, *Trans. Lit. Phil. Soc. N. Y.*, I, 1815, *p.* 424.

Caranx caballus, Günther, *Rep. Shore Fish Challenger Expedition,* 1880, 10; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 48.

We include the Challenger Bermuda record of *caballus* in the synonomy of *crysos.* The specimen upon which it is based cannot be found in the British Museum.

Family SERIOLIDAE

Seriola dumerili (Risso)

Seriola dumerili (Risso).

Caranx dumerili Risso, *Ichthy. Nice,* 1810, 175, *pl.* 6, *fig.* 20.

Seriola lalandi Cuvier and Valenciennes, *Hist. Nat. Poiss.*, IX, 1833, 155 (208); Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 48.

Following Meek and Hildebrand (Marine Fishes of Panama, p. 397) we consider *lalandi* as a synonym of *dumerili*. However, the status of the fishes of the genera *Seriola* and *Zonichthys* is quite confusing, and the entire group is in urgent need of careful study.

Family APOGONIDAE

Apogon sellicauda Evermann and Marsh

Apogon sellicauda Evermann and Marsh 1900.

Apogon sellicauda Evermann and Marsh, *Bull. U. S. Fish. Comm.*, XX, 1900, *p.* 143, *fig.* 40.

Apogon imberbis (not of Linnaeus), Goode, *Am. Journ. Sci. Arts*, XIV, *Oct.* 1877, *p.* 292; Bean, *Field Col. Mus.*, *Zool. Ser.*, VII, No. 2, *p.* 51.

Two Bermuda specimens from the U. S. National Museum collection (Nos. 21,957 and 22,172), one from J. M. Jones and the other from the Mus. West. Univ., have been examined by us. They are labelled *Apogon imberbis*, and presumably are the specimens upon which Goode's identification is based. Goode had considerable Bermuda material from J. M. Jones, and the Jones' specimen bears a number post-dating the second fish, so the probability is that these are the two fish which Dr. Goode identified. Both are deep brown and straw color, having lost all trace of pattern and color. The smaller specimen has been dried at some time and is considerably shrivelled.

The larger of the two fish, 70 mm. standard length (No. 21,957), we identify as *Apogon sellicauda* Evermann and Marsh, of which species we have numerous Bermuda examples.

Until the issuance of Evermann and Marsh's "Fishes of Porto Rico," all of the known West Indian species of *Apogon* possessed relatively large scales, 23 to 26 pores in the lateral line. Probably because of this fact, Dr. Goode considered that the fish mentioned above with 29 lateral line pores was closer to *imberbis*, the Mediterranean Cardinal-fish with 28 to 30 lateral line scales, than any form then known. This was quite consistent with his views as to the European origin of other Bermuda fishes.

However, Evermann and Marsh in their description of *sellicauda* recognized the existence of a small-scaled West Indian form, mentioning 27 scales in the lateral line in the original account of the species. Material subsequently taken shows that the variation in the scale count is from 27 to 29,—counts which include Goode's specimen.

Apogon sellicauda has been synonymized with *A. maculatus* by Metzelaar (1919, p. 59) on the basis of color, and in this he has been followed by Breder (1927, p. 38). However, it seems better to keep the two forms separate until it has been shown that the difference in scale count is of no specific value. As far as color is concerned, while the two forms are exceedingly close, it has not been demonstrated that *maculatus* possesses the conspicuous and large black saddle on the caudal peduncle, nor the coloration of the head and eye of *sellicauda*.

The smaller of the two U. S. National Museum specimens (No. 22,172) belongs to the large-scaled group of West Indian Apogons (approximately 23 pores in the lateral line). While it is definitely not *A. imberbis,* it is in such poor condition that we hesitate giving it a definite name.

Apogon pigmentarius (Poey)

Apogon pigmentarius (Poey).

Monoprion pigmentarius Poey, *Memorias,* II, 1861, *p.* 123.

This species exists in Bermuda as we have found specimens. The specimens recorded under this name by Bean (Field Col. Mus., Zool. Ser., Vol. VII, No. 2, p. 50) have been examined by us. These fish are *Astrapogon stellatus* (Cope), as can be verified by reading Dr. Bean's notes.

Astrapogon stellatus (Cope)

Astrapogon stellatus (Cope).

Apogonichthys stellatus Cope, *Trans. Amer. Phil. Soc.,* XIII, 1869, *p.* 400.

Astrapogon stellatus Fowler, *Proc. Acad. Nat. Sci., Phila.,* LXIII, 1906, *p.* 527.

Apogon pigmentarius (not of Poey) Bean, *Field Col. Mus., Zool. Ser.,* VII, No. 2, *p.* 50.

This species is a common Bermuda form. Bean's fish listed as *Apogon pigmentarius,* belong under this species as stated above,—his specimens possessing the elongate pelvic fins characteristic of this species.

Astrapogon stellatus with its exceptionally long pelvic fins is conspicuously different from its relatives in the genus *Apogonichthys,* and for that reason we prefer to use Fowler's generic name of *Astrapogon.* The following key can be used to differentiate the West Indian genera *Apogon, Apogonichthys* and *Astrapogon:*—

A. Caudal moderately forked . . . . *Apogon*

AA. Caudal rounded.

B. Pelvic fins short, the tips of the fins not or barely reaching to the origin of the anal fin . . . . *Apogonichthys*

BB. Pelvic fins long, their tips reaching far beyond the origin of the anal fin . . . . *Astrapogon*

Family SERRANIDAE

Anthias louisi Bean

Anthias louisi Bean.

Anthias louisi Bean, *Proc. Biol. Soc. Wash.,* XXV, 1912, *p.* 124.

The type of this species, recorded as being in the Bermuda Museum of Natural History, is now in the collection of the American Museum of Natural History, New York City.

Family LUTIANIDAE

Lutianus buccanella (Cuvier and Valenciennes)

Lutianus buccanella (Cuvier and Valenciennes).

Mesoprion buccanella Cuvier and Valenciennes, *Hist. Nat. Poiss.*, II, 1828, 344 (455).

Lutianus aya (not of Bloch) Goode, *Bull. U. S. Nat. Mus.*, V, 1876, *p.* 55; Goode, *Am. Journ. Sci. Arts*, XIV, Oct. 1877, *p.* 292; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 57.

Goode's record of *aya* must belong to this species as he reports a black spot at the base of the pectoral fin, and *buccanella* is the only red Bermudian snapper to which this characteristic could refer. Ginsburg (1930, p. 276) in his paper on red snappers, is also in agreement with this statement. As far as the presence of *aya* in Bermuda is concerned, Bean (1906, p. 57) states that "There is no evidence that *aya* occurs in Bermuda." Our experiences during four years in Bermuda causes us to agree with this statement.

Mowbray (Copeia, No. 108, 1922, p. 49) records *aya* from Bermuda. But considering the status of our present knowledge of the various red West Indian and Bermuda snappers, it seems best to question this record until more detailed material is produced.

Goode's account of *aya* is an extremely interesting one as he confused three separate species and gave them all the name of a fish that did not live in Bermuda. Thus his red snapper, *aya*, refers to *buccanella*, his common name of Yelting refers to the Yellow-tail (*Ocyurus chrysurus*), and the name of Glass-eyed Snapper to *Etelis oculatus*.

Family HAEMULIDAE

Bathystoma aurolineatum (Cuvier and Valenciennes)

Bathystoma aurolineatum (Cuvier and Valenciennes).

Haemulon aurolineatum Cuvier and Valenciennes, *Hist. Nat. Poiss.*, V, 1830, *p.* 176 (237).

Bathystoma aurolineatum, Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 58.

Bathystoma rimator (not of Jordan and Swain) Barbour, *Bull. Mus. Comp. Zool.* XLVI, No. 7, 1905, *p.* 123; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 58.

We have examined the specimens called *rimator* by Barbour (M. C. Z. 32843). The depth of the body in these fish averages 3.2 to 3.45.

As we understand the differences, judging from the literature, between *rimator* and *aurolineatum*, the former species is a deeper form, the depth being from 2.75 to 3 in the length, while in *aurolineatum* the same measurement is from 3.1 to 3.7. This, in addition to the verfication of other characters, would make the specimens mentioned above *aurolineatum*, and we so consider them.

Bathystoma aurolineatum is common in Bermuda, and we have had dozens of specimens, all of which have agreed with our ideas as to the limits of the species. We have never found specimens of *rimator*.

Under any circumstances the genus *Bathystoma* is in urgent need of careful study.

Family SPARIDAE

Diplodus argenteus (Cuvier and Valenciennes)

Diplodus argenteus (Cuvier and Valenciennes).

Sargus argenteus Cuvier and Valenciennes, *Hist. Nat. Poiss.*, VI, 1833, 44 (60).

Sargus variegatus (not of Lacepede) Goode, *Bull. U. S. Nat. Mus.*, 5, 1876, *p.* 52 (account confused with that of *Pimelepterus bosci*).

Diplodus holbrooki (not of Bean) Fowler, *Proc. Acad. Nat. Sci. Phila.*, LXXXI, 1930, 644.

The common Bream of Bermuda is considered by us as *argenteus*, the American form of the genus, rather than as *Sargus sargus* or *S. variegatus* as Dr. Goode recorded it. Dr. Bean (1906) evidently had the same opinion as he ignored the name of the European form in his check-list of Bermuda fishes.

The specimen identified by Fowler as *Diplodus holbrooki* from Bermuda, has been examined and compared with Bermuda Breams. We find no reason for considering it as otherwise than *argenteus*. The specimen is damaged so that exact scale counts are somewhat difficult, but it definitely possesses the smaller scales of *argenteus* as opposed to those of *holbrooki*.

Family GERRIDAE

Eucinostomus californiensis (Gill)

Eucinostomus californiensis (Gill).

Diapterus californiensis Gill, *Proc. Acad. Nat. Sci. Phila.*, XIV, 1862, *p.* 245.

Eucinostomus pseudo-gula Poey, *Enumeratio*, 1875, *p.* 53, *pl.* 1.

Eucinostomus pseudogula Bean, *Field, Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 60.

Eucinostomus harengulus Goode and Bean, *Proc. U. S. Nat. Mus.*, II, 1879, *p.* 132; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 59.

We follow Meek and Hildebrand (Marine Fishes of Panama, pp. 584–586) in placing *pseudogula* and *harengulus* under *californiensis*. Nichols (1929, p. 183) does not agree with this, and it is possible that further study will show that the Atlantic and Pacific forms ought to be separated.

It is of interest to note that our Bermuda specimens of *Eucinostomus gula* and *californiensis* are quite uniform in proportions and counts. The condition of overlapping of one species toward the other, stated by Meek and Hildebrand (582–584) and by Beebe and Tee-Van (1928, p. 167) and found respectively in Panama and Haiti, does not occur in the Bermudian specimens seen by us.

Family CHAETODONTIDAE

Chaetodon ocellatus Bloch

Chaetodon ocellatus Bloch.

Chaetodon ocellatus Bloch, *Naturgesch. Ausl. Fische*, III, *pl.* 211, 1787, 105 (Also from the East Indies); Barbour, *Bull. Mus. Comp. Zool.*, XLVI, No. 7, *p.* 127.

Chaetodon ataeniatus (not of Poey), Bean, *Field Col. Mus.*, *Zool. Ser.*, VII, No. 2, *p.* 73.

We have examined the specimens listed as *ataeniatus* by Bean, and we can see no reason why they should not be considered as *ocellatus.*

Angelichthys bermudensis (Goode)

Angelichthys bermudensis (Goode).

Holacanthus ciliaris var. *Bermudensis* Goode, *Bull. U. S. Nat. Mus.*, 5, 1876, *p.* 43.

Angelichthys isabelitae Jordan and Rutter, in Jord. and Evermann, *Fishes N. and Middle America*, 1898, *p.* 1685.

Angelichthys ciliaris (not of Linnaeus) Barbour, *Bull. Mus. Comp. Zool.*, XLVI, No. 7, 1905, *p.* 127; Bean, *Field Col. Mus.*, *Zool. Ser.*, VII, No. 2, 1906, *p.* 74.

Angelichthys formosus Bean, *Field Col. Mus.*, *Zool. Ser.*, VII, No. 2, 1906, *p.* 74.

Goode in 1876 in his "Catalogue of the Fishes of the Bermudas," gives a color description of a specimen of the common angelfish of Bermuda, listing it under *Holacanthus ciliaris* (Linne) Lacépède. After the color description he gives the following notes,—"My specimens, some twelve in number, differ from all descriptions in the absence of the spot of brown, encircled with blue, on the nape. I have examined numerous West Indian specimens and find it universally present. Should this character prove constant, the Bermuda Angel-fish may be considered a geographical variety, *Holacanthus ciliaris*, var. *Bermudensis.*"

Goode's descriptions and notes agree with the species currently known as *Angelichthys isabelitae*, which is the common angelfish of Bermuda, and it is evident that the latter name must be replaced by *bermudensis* Goode.

The specimens listed by Barbour, and those listed by Bean under *ciliaris* and *formosus* have been examined by us. They are all specimens of *bermudemsis*, the specimen listed under *formosus* being a young fish.

Family POMACENTRIDAE

Demoisellea marginatus (Castelnau)

Demoisellea marginatus (Castelnau).

Heliases marginatus Castelnau, *Anim. Amer. Sud.*, *Poiss.*, V, 1830, 370 (394).

Furcaria cyanea (not of Poey) Barbour, *Bull. Mus. Comp. Zool.*, *Cambr.*, XLVI, No. 7, *p.* 124; Bean, *Field Col. Mus.*, *Zool. Ser.*, VII, 2, *p.* 63.

The Bermuda specimen recorded by Barbour as *Furcaria cyanea* has been examined and compared with the types of *cyanea* which are preserved in the Museum of Comparative Zoology. It differs from that species in posesssing the low type of anal fin characteristic of *marginatus* and *multilineatus*,—differences pointed out by Beebe and Tee-Van (Zoologica, X, 1, pp. 192–194). In its other characters it also agrees with *marginatus*.

The label in the bottle containing the fish, states, "Honda ? Bermuda, Captain Hamilton 1864." We do not know where Honda is located, and since 1864 there is no additional record of the fish in Bermuda. It is possible that it may have been recorded from Bermuda by error.

Whitley (Rec. Austr. Mus., XVI, No. 6, p. 295) has pointed out that *Furcaria* Poey 1860 is preoccupied by *Furcaria* Lesson 1838, and proposes *Demoisellea* in place of Poey's name. This will cause the Bermuda fish of this group to stand as follows: *Demoisellea cyanea* (Poey), *Demoisellea marginatus* (Castelnau), and *Heliases bermudae* (Nichols).

Family CORIDAE

Iridio radiata (Linnaeus)

Iridio radiata (Linnaeus).

Labrus radiatus Linnaeus, *Syst. Nat., Ed.* X, 1758, *p.* 65. *fig.* 6.

Iridio radiatus Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 68; Mowbray, *Fauna Bermudensis*, No. 1, 1931, *6th unnumbered page*.

Iridio elegans Bean, *Proc. Biol. Soc. Wash.*, XIX, 1906, *p.* 30; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, 1906, *p.* 65, *fig.* 6.

Iridio elegans represents one of the immature stages of this species, a fact that has already been noted by Mowbray, and verified by us in a number of individuals.

The inclusion of *Iridio bivittatus* (Bloch) in the synonymy of this species is unwarranted. Both forms are quite distinct and the growth stages of *bivittatus* have been admirably demonstrated by Mowbray (Fauna Bermudensis, 6th unnumbered page).

Iridio maculipinna (Müller and Troschel)

Iridio maculipinna (Müller and Troschel).

Julis maculipinna, Müller and Troschel, in Schomburgk, *Hist. Barbados*, 1848, *p.* 674.

Iridio meyeri Bean, *Proc. Biol. Soc. Wash.*, XIX, 1906, *p.* 29; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, 1906, *p.* 65, *fig.* 7.

Iridio microstomus Bean, *Proc. Biol. Soc. Wash.*, XIX, 1906, *p.* 30; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 67, *fig.* 8.

Iridio maculipinna Bean, *Proc. Biol. Soc. Wash.*, XXV, 1912, *p.* 122.

Iridio frenatus Nichols, *Proc. Biol. Soc. Wash.*, XXXIII, 1920, *p.* 61.

All of the nominal forms mentioned above have been recorded at one time or another from Bermuda, and for a number of years our records of this species were listed under *meyeri*, which is locally quite common.

Recent comparison of these Bermuda specimens called *meyeri* with the older descriptions of *maculipinna* leave no doubt that the two are the same. The species is variable in coloration, but in all of its phases except those of the very young, it possesses dark transverse cross-bars on top of the head, plus a dark spot in the dorsal fin. The bands on top of the head persist through all of the older descriptions of *maculipinna* and they are described either as dark bands, or the interspaces are denoted as pale bands, the divergence being due to discoloration due to preservation.

We have had specimens of the nominal *microstomus* in the field and we consider it as the young of this species, although it lacks the characteristic head markings.

The type of *Iridio frenatus* has also been examined by us and it is a rather dark example of *maculipinna*.

Iridio garnoti (Cuvier and Valenciennes)

Iridio garnoti (Cuvier and Valenciennes).

Julis garnoti Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XIII, 1839, *p.* 285 (390).

Iridio decoratus Bean, *Proc. Biol. Soc. Wash.*, XIX, 1906, *p.* 29; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 64, *fig.* 5.

Our studies in the field show quite conclusively that *decoratus* is but a nominal young form of *garnoti.*

Thalassoma bifasciatum (Bloch)

Thalassoma bifasciatum (Bloch).

Labrus bifasciatus Bloch, *Naturges. Ausl. Fische*, V, 1791, *p.* 131.

Julis nitida Günther, *Cat. Fish Brit. Mus.*, IV, 1862, *p.* 190.

Julis nitidissima Goode, *Am. Journ. Sci. Arts*, XIV, Oct. 1877, *p.* 293.

Chlorichthys bifasciatus Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, 1906, *p.* 68.

Chlorichthys nitidus Bean, *Field Col. Mus., Zool. Ser.*, Vol. VII, No. 2, 1906, *p.* 68.

Bermudichthys subfurcatus Nichols, *Proc. Biol. Soc. Wash.*, XXXIII, 1920, *p.* 62.

Thalassoma bifasciatus Breder, *Bull. Bingham Ocean. Coll.*, Vol. 1, No. 1, 1927, *p.* 60–63.

Thalassoma bifasciatum Beebe and Tee-Van, *Zoologica*, Vol. X, No. 1, 1928, *pp.* 205–206; Tee-Van, *Bull. N. Y. Zool. Soc.*, XXXV, No. 2, 1932, *pp.* 43–47.

Thalassoma nitida Beebe and Tee-Van, *Zoologica*, Vol. X, No. 1, *pp.* 205–206.

Iridio cyanocephalus (not of Bloch) Barbour, *Bull. Mus. Comp. Zool.*, XLVI, No. 7, 1905, *p.* 125.

The synonymy of this species, as far as *T. bifasciatum* and *T. nitida* is concerned, has been proven quite conclusively by Breder (1927), Beebe and Tee-Van (1928) and Tee-Van (1932) (l. c.).

The type of *Bermudichthys subfurcatus* in the American Museum of Natural History, which we have examined, is a damaged specimen of this species. The apparent differences in fin ray counts do not exist when the specimen is examined under a binocular microscope, and in teeth and color it does not differ from similar dark specimens from Bermuda. We consider the tail as lunate, not forked.

A Bermuda specimen in the Barbour collection at the Museum of Comparative Zoology labelled *Iridio cyanocephalus*, and presumably that upon which the Barbour record is based, is an exceedingly dark specimen of the Blue-head, *Thalassoma bifasciatum*. Barbour used the common name Blue-head for his specimen, so that the change in record is also supported by that evidence. We have never found true *cyanocephalus* at Bermuda, so that the name can be expunged from Bermuda faunal lists.

Family SPARISOMIDAE

Cryptotomus roseus Cope

Cryptotomus roseus Cope.

Cryptotomus roseus Cope, *Trans. Amer. Phil. Soc.*, XIV, 1871, *p.* 462.

Cryptotomus crassiceps Bean, *Proc. Biol. Soc. Wash.*, XIX, 1906, *p.* 32; Bean, *Field Col. Mus., Zool. Ser.*, VII, 1906, No. 2, *p.* 70.

We follow and agree with Fowler (1915, p. 257) in synonymizing the nominal color form *crassiceps* with *roseus*. Bermuda specimens taken by us are in accord with this merging.

Sparisoma radians (Cuvier and Valenciennes)

Sparisoma radians (Cuvier and Valenciennes).

Scarus radians Cuvier and Valenciennes, *Hist. Nat. Poiss.*, XIV, 1839, *p.* 153 (206).

Sparisoma radians Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 72.

Scarus hoplomystax Cope, *Trans. Amer. Phil. Soc.*, XIV, 1871, *p.* 462.

Sparisoma hoplomystax Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 72.

Sparisoma xystrodon Jordan and Swain, *Proc. U. S. Nat. Mus.*, VII, 1884, *p.* 99; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 73.

We follow Meek and Hildebrand in synonymizing the above species. Bermuda specimens are in agreement with this merging.

Family GOBIIDAE

Rhinogobius mowbrayi Bean

Rhinogobius mowbrayi Bean.

Rhinogobius mowbrayi Bean, *Field Col. Mus., Zool. Ser.*, VII, 1906, No. 2, *p.* 81, *fig.* 12.

Leptophilypnus crocodilus Beebe and Tee-Van, *Zoologica*, Vol. X. 1928, No. 1, *p.* 219, *fig.*

The type of *Leptophilypnus crocodilus* Beebe and Tee-Van, has been compared with Bermuda specimens of *Rhinogobius mowbrayi*. They are undoubtedly the same, and the misidentification arose mainly because of the damaged ventral fins of the Haitian specimen, which produced an eleotrid-like appearance.

Lophogobius glaucofraenum (Gill)

Lophogobius glaucofraenum (Gill).

Coryphopterus glaucofraenum Gill, *Proc. Acad. Nat. Sci. Phila.*, 1863, *p.* 263 (Reported from the Coast of Washington,—the latter statement evidently an error).

Rhinogobius glaucofraenum Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 81.

Gobius translucens Nichols, *Bull. Amer. Mus. Nat. Hist.*, XXXIV, 1915, *p.* 145, *fig.* 2; Nichols, *Proc. Biol. Soc. Wash.*, XXXIII, 1920, *p.* 63.

Lophogobius pallidus Parr, *Bull. Bingham Oceano. Coll.*, Vol. III, Art. 4, 1930, *p.* 122, *fig.* 33; Beebe and Tee-Van, *Zoologica*, Vol. XIII, No. 5, 1932, *p.* 120.

In recently examining specimens that had been assigned in the field at Bermuda to *glaucofraenum* and *translucens* a well-marked dermal crest was noticed. The crest is similar to that described and illustrated by Parr in his description of *Lophogobius pallidus*. These well-preserved Bermuda fish have been compared with the type of *translucens* with which they agree in form, pattern and in all other characters except that of the dorsal crest. The type of *translucens*, however, is somewhat shrivelled as far as the top of the head is concerned, and while the crest does not show, we believe that this is because of methods of preservation. It does, however, possess the conspicuous pigment spots that appear on the dermal ridges of the Bermuda specimens, and there is no doubt in our minds but that the type of *translucens* and the Bermuda specimens are the same.

Judging from Bermuda specimens there is no reason for maintaining *translucens* separate from *glaucofraenum*, as the difference in scale counts and color cause them to overlap. We have not been able to examine the types of *glaucofraenum*, but we have no compunction in synonymizing the two forms.

The specimens recorded from Bermuda by Beebe and Tee-Van as *Lophogobius pallidus* are also the same as the specimens mentioned above. They agree so well with Parr's original description that we consider *pallidus* as a synonym of *glaucofraenum*.

Parr, in his description of *pallidus*, grouped it with *L. cyprinoides* in the genus *Lophogobius*, and in our present state of knowledge of West Indian gobies, such a procedure seems to be quite proper in the present case. It must be noticed, however, that the crests are quite different in the two species,—the crest of *cyprinoides* being rather high, thin and membranous in the living fish, incapable of supporting itself when the fish is out of water, while the crest of *glaucofraenum* is low, rather wide, relatively ridge-like and by no means membranous. Whether these distinctions can be correlated with others to establish a different generic status for the two forms is a future problem.

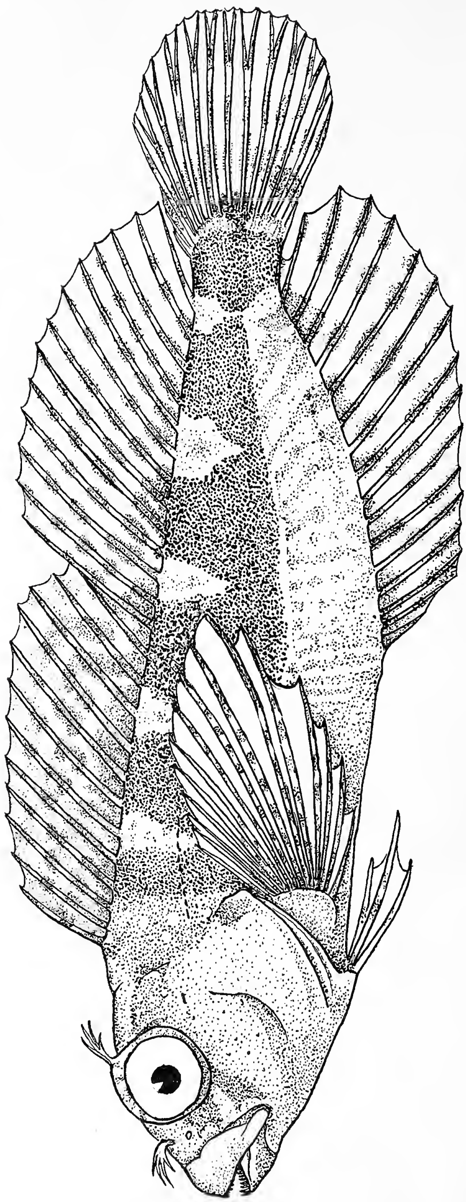

Fig. 38. *Hypleurochilus bermudensis* sp. nov.

Family CALLIONYMIDAE

Callionymus bermudarum Barbour

Callionymus bermudarum Barbour.

Callionymus bermudarum Barbour, *Bull. Mus. Comp. Zool.*, XLVI, No. 7, 1905, *p.* 129; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, *p.* 81.

Callionymus dubiosus Parr, *Bull. Bingham Oceano. Coll.*, III, 1930, No. 4, *p.* 130, *fig.* 36; Beebe and Tee-Van, *Zoologica*, XIII, No. 5, 1932, *p.* 120.

During the various years at Nonsuch Island a number of examples of *dubiosus*, recently described by Parr from the Bahamas, were obtained. One of these examples has been compared by Parr with the type, from which it differed very slightly.

In 1932 the junior author examined the types of *bermudarum* in the Museum of Comparative Zoology at Cambridge as well as our Bermuda material. Although our materials representing *dubiosus* have not been directly compared with the types of *bermudarum*, it is quite certain that the two forms are identical.

Parr was justified in erecting a new species for his material as the original description of *bermudarum* mentions only three dorsal spines, while Parr's material had four. In a re-examination of the type of *dubiosus* a fifth rudimentary spine was found,—this spine being well developed in the Bermuda fish. However, examination of the types of *bermudarum* show that there are 5 and possibly 6 spines. The spinous dorsal fins in this type material are in poor condition, and have evidently been damaged, making accurate counting difficult, but there are certainly more than three spines in each of the fishes examined. The discrepancy between the specimens and the description was noted before, as there is a label in the bottle containing the types, presumably written by Dr. Garman, stating "D 7 + 7, A 5."

In color, opercular spines, lateral body keels, and other characters not mentioned in the description of *bermudarum*, the two forms are alike, and *dubiosus* ought to be placed in the synonymy of *bermudarum*.

Family BLENNIDAE

Hypleurochilus Gill 1861

Hypleurochilus bermudensis sp. nov.

Type: No. 33070, Museum of Comparative Zoology, Cambridge (Field No. 440), Marshall Island, Bermuda, August 8th, 1918. Standard length 40 mm.

FIELD CHARACTERS: Small, short-headed, rather compressed, scaleless fish with small pelvic fins of three rays each; gill-openings confined to the sides only, the membrane fully attached to the isthmus below. A short multifid tentacle above the eye and a multifid one on the anterior nostril. Color brownish to yellow-buff, heavily barred above and mottled with dark brown. Vertical and paired fins with small brown spots on the rays.

MEASUREMENTS AND COUNTS: Total length 49 mm.; standard length 40 mm.; depth 9.8 (4 in length); width of body 6.8; head 12.5 (3.2 in length); eye

3.5 (3.6 in head); interorbital space 1.5 (8.2 in head); snout 4.2 (3 in head); maxillary 4.3 (2.9 in head); snout to dorsal fin 10.8 (3.7 in length); snout to anus 24 (1.66 in length); depth of caudal peduncle 3.7 (3.4 in head); distance between openings of gill-slits ventrally 4.8 mm.; dorsal fin XII, 13; anal fin I, 15; pectoral rays 15; pelvic rays 3; pectoral length 12.3 mm.; pelvic length 8.6 mm.; scales absent.

Body compressed, especially posteriorly, deepest just behind the pectoral fins. Anterior profile with a slight downward curve immediately in front of the dorsal, then straight and slightly downward to the orbit. Profile from eye to snout straight, oblique, and at a considerable angle from the dorsal profile.

Skin naked. A four-fingered dermal tentacle over the eye slightly posterior to the eye's vertical axis, the length of the tentacle slightly more than half the height of the eye. No cirri on the nape. A multifid cirri on the anterior nostril.

Lateral line prominent, rather high up on the side, short and present on the anterior sides only, ending under the 9th dorsal spine on the right side and under the 11th dorsal spine on the left side.

Head somewhat deeper than wide; opercles smooth, the opercle ending posteriorly in a deep bay, the membrane of the opercle continued posteriorly into an obtuse flap. Gill-membranes united to each other and completely attached to the isthmus below, the gill-openings thus restricted to the sides.

Snout obtuse, its length slightly greater than the diameter of the eye.

Eye not quite round, its longest diameter oblique, medium in size (3.5 in head); its upper edge entering the dorsal profile. Interorbital space narrow (8.2 in the head).

Anterior nostril with a multifid tentacle on its posterior aspect. Posterior nostril close to the eye, without appendages. Mouth, rather small; the lips, especially the upper, rather full; maxillary extending to slightly beyond the anterior margin of the pupil.

Teeth firmly set on the jaws, their tips obtusely pointed; in a single row in each jaw, each tooth considerably curved and with a cusp on its inner basal aspect. The teeth of the upper jaw are followed posteriorly by a short space and then a single canine, in shape and size much like the remaining jaw teeth.

Dorsal fin continuous, the spines shorter than the rays, the base of the spinous portion slightly longer than that of the soft dorsal. The 1st spine is 4.2 mm. high; the fin then slowly ascends to the 5th to the 9th spines which are all 5.8 mm. high, and then descends to the 12th which is 3.5 mm. The rays are abruptly higher, the first ray being 6.5 mm. high, the 5th to the 7th being 7.8 mm. while the 13th is 3.6 mm.

The anal fin is lower than the dorsal, the highest rays being 11th to 13th, which are 6 mm. Tips of the anal rays curved backward.

Pectoral fins extending to the vertical of the first dorsal ray, the 5th ray from the bottom longest, the lower rays much thicker and heavier than the others. Base of the pectoral nearly vertical.

Pelvic fins inserted anterior to the pectorals and immediately in back of the attachment of the gill membranes to the isthmus. Third ray considerably shorter than the anterior two, the second of which is the longer.

Color (Alcoholic specimen): General color of head brownish, that of the body yellowish-buff, becoming lighter posteriorly. Body with six large dark brown blotches on the upper two-thirds of the sides, broadest in the middle of the sides and in some cases connected with each other. Remainder of body freckled with small spots of lighter brown. Vertical and paired fins with small brown spots on the rays, forming in some cases irregular bands, most prominent on the anal, spinous dorsal and caudal fins.

Discussion: This species differs from *H. geminatus*, the only other described Atlantic species of the genus, in size of head, anal fin count, presence of canines in the upper jaw only, emarginate dorsal fin, and in color.

Family ANTENNARIIDAE

Antennarius radiosus Garman

Antennarius radiosus Garman.

Antennarius radiosus Garman, *Bull. Lab. Nat. Hist. Iowa Univ.*, 1896, *p.* 85, *pl.* 1; Bean, *Field Col. Mus., Zool. Ser.*, VII, No. 2, 1906, *p.* 89.

We have examined the specimen (U. S. Nat. Mus. No. 50,000) upon which Bean based the Bermuda record. It agrees well in general form and fairly well in color with the original description of *radiosus*, but differs in possessing a short 1st dorsal spine,—the spine itself, excluding the filaments, being of about the same length as the second dorsal spine. Unfortunately, both of these spines were broken off in our examination of the specimen.

Considering the sparseness of material and our lack of knowledge of variation within the group, it seems best to retain the identification given by Bean to this specimen, and to point out that it is by no means typical.

In the "Field Book of Shore Fishes of Bermuda" mentioned in the introduction to this paper, only the strictly shore-living species and the commoner pelagic forms such as flyingfish and dolphins are treated. The following species, already reported in the ichthyological literature of Bermuda will be included in future reports on the Deep-sea Fishes of Bermuda:

Amphioxides pelagicus Günther.
Etmopterus pusillus Lowe.
Lampanyctus crocodilus (Risso).
Coelorhynchus occa (Goode and Bean).
Regalecus glesne Ascanius.
Brama raii (Bloch).
Lirus maculatus Günther. (Reported as *Centrolophus* sp. by Goode).
Psenes pellucidus Lütken.
Eucrotus ventralis Bean.
Macrorhamphosus scolopax (Linnaeus).
Mola mola (Linnaeus).
Ranzania truncata (Retzius).

After this paper was in page proof, we received an excerpt of Dr. W. H. Longley's paper, "Preparation of a monograph on The Tortugas fishes" (Carnegie Institute Year Book, No. 31, 1931–1932, pages 299–300). It is a matter for congratulation that in the difficult field of synonomy of the West Indian fish fauna, the majority of our conclusions, arrived at independently, are identical with those of Dr. Longley.

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DEEP-SEA ISOSPONDYLOUS FISHES

TWO NEW GENERA AND FOUR NEW SPECIES

By William Beebe

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DEEP-SEA ISOSPONDYLOUS FISHES[1]
TWO NEW GENERA AND FOUR NEW SPECIES

By William Beebe

(Figs. 39 to 42 incl.)

This is the second installment of descriptions of new forms of deep-sea fish taken on the Bermuda Oceanographic Expeditions of the Department of Tropical Research of the New York Zoological Society. They were all taken within the eight-mile circle whose center is at 32° 12′ North Latitude and 64° 36′ West Longitude, nine and one quarter miles south-southeast of Nonsuch Island, Bermuda.

The descriptions are published here in advance of the final ecological studies of the families to which these new forms belong. The monographs will appear very shortly.

Figures 39, 40, 41 and 42A are by Helen Tee-Van; figure 42B by Edward Delano.

LIST OF SPECIES

Anomalopterus megalops sp. nov.

Type: Department of Tropical Research No. 11,456; *Bermuda Oceanographic Expedition of the New York Zoological Society; Net* 280; *July* 10, 1929; 12 *miles south of Nonsuch Island, Bermuda;* 700 *fathoms; Standard length* 31 mm.

Measurements and Counts: Standard length 31 mm; depth 7.8 (in length 4); head 15.3 (in length 2); maximum thickness 6.5 (in length 4.8); eye diameter, without fold, 3.3 (in head 4.6); eye fold .48; snout 3.8 (in head 4); maxillary 8.2 (in head 1.9); interor-

[1] Contribution, New York Zoological Society, Department of Tropical Research, No. 415.

bital 2.4 (in head 6.4); branchiostegal rays 7, partially united beneath the isthmus; pectoral rays 7; pectoral length 1.9; pelvic rays 7; pelvic length 2.5; dorsal rays 21; anal rays 20.

General Description: Due to the enormous size of the head, the

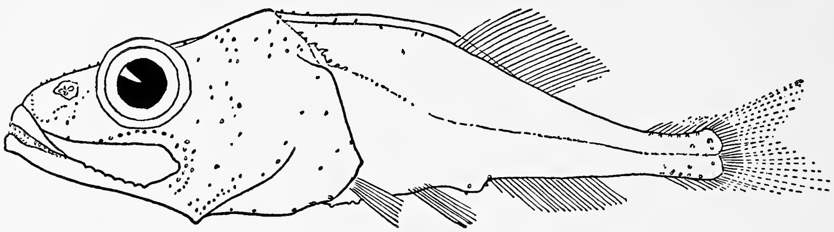

Fig. 39. *Anomalopterus megalops* sp. nov.

deepest part of the body falls far back, at about the middle of the length. From here it slopes forward gradually to a deep, blunt snout, and more rapidly posteriorly, ending in an elongated, slender peduncle.

The large eyes are high on the head, interrupting the dorsal profile, and the eye-ball is surrounded by a thick, fleshy fold, making these organs look even larger than they are. The nostrils are conspicuous, slightly nearer the anterior margin of the eye than the tip of the snout, and are above a line drawn between these two places. The narial area is very large, measuring a millimetre in diameter. The mouth is of great size, with a slight downward slope posteriorly, the maxillary ending just short of the posterior vertical of the eye.

The teeth are small, slightly curved, and present on the premaxillary, maxillary and the anterior part of the mandible. The maxillary teeth are seven in number and alternate with shallow, rounded scallops. The vomer and palatines are edentulous.

The gill openings are large; the opercula are covered with skin and the posterior margin is smooth.

The skin is scaleless and smooth except for numerous small tubercles, abundant on the head, and less so on the body, where they are scattered along the dorsal fold and the lateral line, around the anus and at the base of the caudal fin. A low dermal ridge begins at the nape and extends halfway down the back, encroaching considerably upon the anterior portion of the dorsal fin. The latter occupies about the middle third of the back. The anal originates at the

vertical from the middle of the dorsal, and extends about half its length behind the dorsal. The pectorals are inserted close to the ventral profile and are very short. The pelvics, of equal length, originate well in advance of the dorsal fin.

Discussion: My specimen, No. 11,456, must be referred to the genus *Anomalopterus* on the basis of the two dominant generic characters—the enormous size of the head and the presence of the adipose fold preceding the dorsal fin, unless a new genus be made due to the presence both of maxillary teeth and of dermal tubercles in the present specimen.

The only other species, and in fact individual of the genus, *Anomalopterus pinguis*, was described by Vaillant,[2] from off northern Africa, at a depth of 1400 metres or 765 fathoms.

Anomalopterus megalops differs from Vaillant's species in the much larger eye (4.6 in head, not 20), the presence of teeth on the maxillary, the conspicuous nostrils, increased vertical finray counts and the presence of tubercles on the skin.

Even allowance for a difference in age (*pinguis* is twice as long as *megalops*) could not account for the greatly disproportionate size of the eye, the inconspicuousness of the nostrils and the total absence of dermal tubercles.

The type is in the collection of the Department of Tropical Research of the New York Zoological Society.

Macromastax gen. nov.

Generic Characters: Elongate, moderately compressed Aleppocephalids, with naked, delicate skin, no sign of tubercles, and no nuchal dermal fold; lateral line distinct; the head large (less than 3 in length); mouth very large, with the maxillary reaching far behind the posterior margin of the orbit; the jaws nearly equal; snout short; teeth uniserial, absent from the vomer, but present on the premaxillary, maxillary, mandible and palatine; eye large; the gill membranes not joined beneath the isthmus; 9 branchiostegals; the paired fins are close to the ventral profile; the pectorals small and feeble; the pelvics well developed, just within the posterior half of the fish; the dorsal is about twice as long as the anal, originating far in advance of it, at the vertical of the pelvic base; caudal well developed, forked.

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[2] 1888—Poissons, Exp. Scient. Talisman et Travailleur, pp. 160–162; Pl. XI, fig. 4, 4a.

Comparison with Other Genera: This genus is immediately distinguishable from other scaleless Alepocephalids by the following characters:

From *Xenodermichthys* and *Rouleina* by the inequality of the vertical fins, the forward position of the dorsal, and the great size of the maxillary.

From *Leptoderma* by the shortness of the vertical fins, the fact that the dorsal is longer than the anal instead of vice versa, and by the great size of the maxillary.

From *Anomalopterus* and *Photostylus* (see pgs. 60 and 64) by the absence of an adipose fold in front of the dorsal fin.

In addition to its lack of scales, *Macromastax* differs most obviously from the remaining Alepocephalids which have short snouts, pelvic fins and maxillary teeth as follows:

From *Bathytroctes* (including *Talismania*) in the great length of the maxillary, in the presence of 9 instead of 7 branchiostegals, and in the absence of vomerine teeth.

From *Bajacalifornia* in the lack of a pointed, symphysial knob, and in the large size of the maxillary.

From *Narcetes* in having uniserial instead of polyserial teeth, and more than seven branchiostegals.

Macromastax gymnos sp. nov.

Type: Department of Tropical Research No. 10,829; Bermuda Oceanographic Expedition of the New York Zoological Society; Net 210; June 22, 1929; eight miles south of Nonsuch Island, Bermuda; 1000 fathoms; Standard length 35 mm.

Measurements and Counts: (These measurements were made from the fresh specimen). Total length 42.2 mm; standard length 35 mm; depth 6.5 (in length 5.4); head 12.8 (in length 2.7); eye 3.5 (in head 3.7); snout 2.1 (in head 6.1); maxillary 8.5 (in head 1.5); pectoral ca. 10; pectoral length 2.2; pelvic 7; pelvic length 6.3; dorsal 25; anal 12; 9 branchiostegals.

General Description: Body deepest immediately behind the large head; dorsal and ventral profiles almost horizontal, the slope being very slight to the short, thick peduncle. Top of head straight, dipping abruptly at front of eye to the short, blunt snout. Eye very large, almost filling the space between the top of the head and the maxillary line; pupil elliptical. Nostrils conspicuous, half-way be-

tween eye and snout. Maxillary straight, slanting obliquely downward and back, extending almost the diameter of the eye behind the posterior margin of the orbit.

There are 5 short, recurved teeth on each premaxillary ramus,

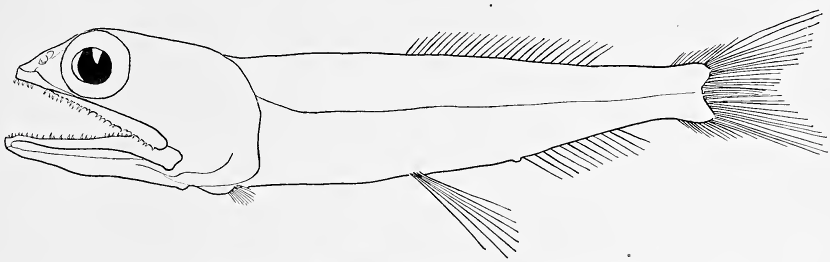

Fig. 40. *Macromastax gymnos* gen. et sp. nov.

and 24 along the maxillary, separated and rather irregular; on the posterior third these tend to be arranged in pairs; on the mandible are 44 teeth, equally small and curved; some of these are not in perfect alignment, but there is no evidence of biseriality; each palatine has 6 teeth, but there are none on the vomer.

Type in the collections of the Department of Tropical Research of the New York Zoological Society.

Photostylus gen. nov.

This genus differs from all the Alepocephalidae except *Anomalopterus* in having a prominent pre-dorsal fold or adipose fin along the back. It differs from that and other closely related genera (such as *Rouleina* and *Xenodermichthys*) in its steeply ascending, concave snout, small head and relatively high and well developed pectoral fins. The skin is without scales; the jaws are equal, with a prominent symphysial knob; the mouth moderately large; teeth present on the premaxillary, maxillary, mandible and palatine; 6 branchiostegals; pectorals large and placed high; pelvics small, inserted at about the middle of the body; vertical fins almost equal, far back.

Photostylus pycnopterus sp. nov.

Type: Department of Tropical Research No. 10,217; Bermuda Oceanographic Expedition of the New York Zoological Society; Net 137; May 30, 1929; 9 miles south-east of Nonsuch, Bermuda; 800 fathoms; Standard length 64 mm.

Measurements and Counts: (From fresh specimen, now shrunken slightly as to length and eye). Total length 71 mm; standard length 64 mm; depth 9.2 (in length 6.9); head 11 (in length 5.9);

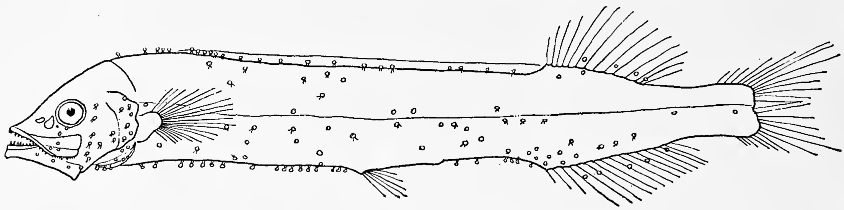

Fig. 41. *Photostylus pycnopterus* gen. et sp. nov.

eye 2.5 (in head 4.4); interorbital 2.5 (in head 4.4); snout 4 (in head 2.7); maxillary 5.8 (in head 1.9); branchiostegals 6; pectoral rays 18; longest pectoral ray 4.3; pelvic rays 6; pelvic length 4; dorsal 13½; anal 17½; caudal rays ca. 35; caudal tip broken.

General Description: Considerably elongate and compressed; body profiles almost horizontal, sloping very slightly backward to the tail; the nape is somewhat elevated, and the head depressed, the top of the head curving evenly down to the eye, from whence to the tip of the snout the profile is concave; the ventral profile of the mandible extends obliquely downward, with a prominent posterior angle, well below the profile of the head; the vertical fins arise from elevated, fleshy bases, considerably increasing the depth of the posterior body profile.

Head and eye both small; nostrils large, nearer eye than tip of snout; jaws equal in front, the symphysis of the mandible prolonged downward into a prominent knob; maxillary flat and greatly widened posteriorly, extending to the vertical of the posterior border of the eye.

Small teeth in uniserial rows are present on the premaxillary (27), maxillary (17), mandible (24), and palatine (2); the vomer is toothless; the teeth are close-set, but besides the symphysial gaps, there are other, occasional, narrow, asymmetrical gaps and a few replacement teeth.

The head and body are covered with an irregular scattering of photophores, elevated on stalks: these consist of a terminal, pigmented body, with a white or iridescent summit, the whole elevated on a thick, colorless stalk.

From the inter-mandibular membrane arise four pairs of singular looking organs, leaf-like but rather thick and dead white. Together with several small, adjacent patches, these seem to form an illuminating organ, comparable with nothing with which I am familiar in any other Alepocephalid.

On the nape, just back of the vertical of the fleshy base of the pectorals, there rises a thick, fleshy, median fold or adipose fin. This increases slightly in height and extends back to the dorsal, where it merges with the raised, fleshy base of that fin.

The type is in the collections of the Department of Tropical Research of the New York Zoological Society.

Macrostomias calosoma sp. nov.

Type: Department of Tropical Research No. 18,781; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 890; September 15, 1930; 12 miles south-east of Nonsuch Island, Bermuda; 600 fathoms; standard length 430 mm.

Measurements and Counts: (Made from the fresh specimen). Total length 450 mm; standard length 430 mm; depth 21 (in length 20.5); head 27 (in length 15.9); eye 6 (in head 4.5); snout 6 (in head 4.5); maxillary 28; mandible 33; interorbital 6 (in head 4.5); pectoral rays 6; pectoral length, longest ray 20, shortest rays 1.1; pelvic rays 5; pelvic length 60; dorsal rays 14; anal rays 15; snout to pectoral 30; snout to pelvic 236 (in length 1.8); scales, in a longitudinal series, 164; barbel 300 (in length 1.4, divided by head 11). Photophore counts: Hyoid 22; lateral series, P-V 79, V-A 59; ventral series, I-P 12, P-V 80, V-A 60, A-C 20.

General Description: Exceedingly long and slender, the head scarcely deeper than the body and typically Stomias-like in form.

Teeth: All slender and curved; premaxillary 6, the second a long, curved fang, first and third very small, others slightly larger; maxillary 11; mandible 10 in each half, the second long, curved, somewhat shorter than the corresponding tooth in the upper jaw, others small, sixth to tenth very small, in posterior part of jaw, in two sets of two and three; vomer 1 pair; palatines 3 pairs.

There is a round cheek light obliquely below and back of the eye. The barbel is longer and more complicated than that of *M. longibarbatus*, the other species of the genus, and takes rank with the most specialized organs of the family. It arises far forward in

Fig. 42. *Macrostomias calosoma* sp. nov. A. Lateral view; B. End of bar bel.

the intermandibular tissue in front of the photophores, swung from a stout mass of translucent muscle. The very long stem is transparent, showing a thin, central core, and is dotted, sparsely and irregularly, with small, black chromatophores. It narrows very gradually and near the end is only about half the basal diameter. The tip consists of a long, narrow spindle of pale yellow, luminous tissue. Just above this arise two branches, the superior one short and of irregular shape, the inferior with a long stem ending in a burst of luminous yellow beads. From the origin of this pair to the tip of the bulb are about a dozen lateral branches, no two alike, some with a stem of luminous beads, others with only a terminal brush of filaments. At the extreme tip of the bulb arise several, slender, thread-like filaments. The whole forms a luminous organ of considerable power, which when glowing must look like a tassel of filmy, luminous threads.

Many clusters of small photophores are scattered on the head and around the bases of the fins, while each scale contains a light in its lower central portion. All of these, as well as the serial photophores, are directed straight downward, except the hyoid lights which point obliquely downward and back, and the subocular which is directed slightly up and back.

The pectoral fin is rather short, well formed, but of a specialized, translucent, white tissue, very evidently luminous. The rays of the pelvics are extremely long and slender, not tipped with luminous bodies as in *M. longibarbatus*. They are placed slightly behind mid-body.

Comparison: The genus *Macrostomias* is known from one other species, *M. longibarbatus* Brauer, recorded from the eastern Atlantic and Indian Oceans. *M. calosoma* differs from *M. longibarbatus* in its longer and more elaborate barbel (head contained in barbel's length 11 not 7 times); its greater depth (20.5 not 33 in length); fewer V-A photophores (59 instead of 67 to 68 in the lateral series); more numerous teeth; slightly larger eye; slightly longer snout; and in having a round, not elongate, suborbital organ.

Type in the collections of the Department of Tropical Research of the New York Zoological Society.

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